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SCIENCE ABSTRACTS

SECTION A.—PHYSICS.

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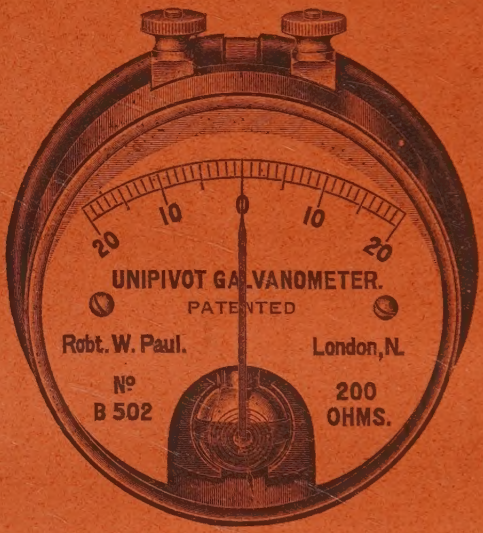

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AUGUST 1913.

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SCIENCE ABSTRACTS.

Section A.—PHYSICS.

AUGUST 1913.

GENERAL PHYSICS.

1235. *Spurge's Manometer.* (Engineer, 115. pp. 535–536, May 16, 1913.)—The article commences with a brief review of Torricelli's mercury manometer which still serves as a standard. The use of this for the accurate measurement of high pressure is critically examined, reference being made to instruments at the Eiffel Tower in Paris, at Manchester, St. Etienne, and in a well at Butte aux Caille, the length of the tube in the latter case being 1600 ft. and capable of measuring pressures of 9000 lbs. per sq. in. Disadvantages of such long tubes are pointed out. The dead-weight instrument, a more convenient form of manometer, is then described, but here again there is disadvantage when pressure variations have to be followed and noted, not to mention portability. Tait's method of checking the *Challenger* results is then described in detail, this forming the basis of Spurge's new type of manometer. Here advantage is taken of the elastic strain set up in a hollow cylinder or shell. A minute description of the instrument then follows, accompanied by diagrams. A table of corrections, supplied by the National Physical Laboratory, is added, whereby comparison is made with their dead-weight instrument. A mathematical discussion of these results then follows. The instrument has proved very serviceable when required to determine hydraulic pressure with precision. H. H. Ho.

1236. *New Micromanometer.* **J. D. Fry.** (Phil. Mag. 25. pp. 494–501, April, 1913.)—The principle of the instrument is very simple, the difference of pressure to be measured being applied to the two sides of a stretched circular membrane so arranged that the centre of the membrane by its displacement twists a mirror which is suspended in a special manner, the pressure-difference being finally indicated by the deflection of a spot of light on a scale. With certain slight modifications, a manometer working on this principle may be adapted to the measurement of small differences of pressure at any absolute pressure. The present instrument has been designed for use at atmospheric pressure, and the author claims that in its most delicate form the new manometer possesses a sensitiveness at least ten times that of any micromanometer previously described. Since the displacement of a stretched membrane is dependent on its tension and stiffness, in order that it may be

proportional to the pressures applied it is important that of the two factors the tension should predominate, and to achieve this it is necessary to use a very thin membrane and to arrange that the tension to which it is subjected is considerable. If stiffness be neglected, the tension will remain constant when the displacement is small, the latter then being $pr^2/2T$, where p is the pressure-difference between the two sides, r the radius of the membrane, and T the tension in the membrane. The selection of the membrane depends on the order of magnitude of the pressure-differences required to be measured, and the following substances were tried: Thin sheet-rubber (which, although of extreme sensitiveness, cannot be put under sufficient tension to eliminate entirely a drift of zero), goldbeater's skin, cyclostyle paper, thin copper, and Badische coated with thin petrol-resin varnish to render it air-impervious. The latter proved the most suitable for indicating the smallest pressures. The construction of the manometer is then described in detail. All connections should be made with tubes of reasonably large diam., since with small-bore tubes effects due to viscosity become troublesome, and the manometer takes a considerable time to attain its final reading. The instrument must be calibrated, since the constant cannot be found *a priori*, and a special method is described, calibration curves being given under different conditions of sensitiveness. A table is added giving references to various recognised types of sensitive manometer, thereby serving as a rough comparison in relative sensitiveness. H. H. Ho.

1237. *Orthophotography.* **J. M. Lahy.** (Comptes Rendus, 156. pp. 1314–1317, April 28, 1913.)—Describes, with the aid of numerous diagrams, an apparatus designed to effect the correction (or rectification) of curves deformed by the circular movements of the style used for tracing the curves. A. W.

1238. *Work of the Reichsanstalt in* 1912. (Zeitschr. Instrumentenk. 33. pp. 84–98, March; 111–130, April, and pp. 152–172, May, 1913.)

1239. *Elastic Constants of Quartz Glass.* **F. Stumpf.** (Ann. d. Physik, 40. 5. pp. 879–886, April 29, 1913.)—The bending and torsion constants E and T were determined for four rods of amorphous quartz of rectangular section, using Voigt's apparatus. The mean values obtained are—

$$E = 7123 \text{ kg./mm.}^2, \quad T = 3145 \text{ kg./mm.}^2.$$

Hence Poisson's ratio $\mu = 0{\cdot}133$. These values of E and T are slightly higher than most of the values previously found by other experimenters. A discussion of the results by W. Voigt shows that they do not support the theory of the quasi-isotropy of quartz glass. A. W.

1240. *Elasticity of Thin Shells.* **E. Meissner.** (Phys. Zeitschr. 14. pp. 343–349, April 15, 1913.)—The theory of the elasticity of thin shells curved according to a surface of rotation and loaded with axial symmetry requires the integration of a differential equation of the fourth order, which is complicated even in simple cases. The author shows that a reduction to a differential equation of the second order takes place when the curvature of the meridian of the surface is constant, *i.e.* in the case of spheres, cones, and rings. The methods of integrating these equations are developed, thus enabling us to calculate the strength of such shells. The theory of a spherical vault is completely given. E. E. F.

1241. *Collapse of Tubes by External Pressure.* **R. V. Southwell.** (Phil. Mag. 25. pp. 687–698, May, 1913.)—The author commences by referring to Basset's work in 1892, where a very clear exposition is given of the difficulties encountered in attempting to construct a theory of flue collapse. The conclusions arrived at show that Bryan's formula for the collapsing pressure of an infinitely long flue is probably correct as a first approximation, when the inner surface of the tube is free from applied pressures. Basset's work, however, is vitiated by the employment of a faulty expression for the strain energy of bending, and while the formula may be obtained by other methods, these also must be based upon inexact assumptions. The author claims to have investigated the problem by an exact method not involving the theory of thin shells. The results obtained show that Bryan's formula is correct as a first approximation, even when both surfaces of the tube are subjected to pressure, the difference of the pressures being the sole criterion of collapse. The conclusion reopens the examination of the theory of thin shells, since it appears more capable than hitherto supposed of providing a satisfactory formula for flue collapse, and the author indicates alterations in method which in his opinion evade Basset's difficulties. An extension of Bryan's formula then suggests estimates for the influence of "collapse rings" upon the strength of flues. Basset's notation being retained, the boiler-flue problem is thus stated: "Let the flue be regarded as indefinitely long and cylindrical; let $a+h$ and $a-h$ be the external and internal radii of its surfaces, π_1 and π the respective outer and inner pressures. Then the condition of stability requires that a certain relation should exist between these four quantities, viz.: $F(a, h, \pi_1, \pi_2) > 0$." Basset suggested two methods for attacking the problem, viz. first the assumption of a slight deformation of the flue, when the condition of stability requires that the period of the small oscillations should be a real quantity; and second, that the potential energy in the deformed state being found, it should be a minimum for the equilibrium position. The value of the function F will be determined by either of these methods. The author proposes a third method, whereby the conditions which must obtain if a circular tube is in neutral equilibrium under the action of external pressure are investigated. Having found a value of the pressure for which the equilibrium is neutral, then by changing the equation into an inequality the stability condition is expressed. No alteration of Basset's methods is therefore involved, except the substitution of equations of equilibrium for his equations of small motion. Two configurations are then distinguished, viz. (1) the equilibrium position in which the tube remains circular and merely suffers contraction; (2) a configuration of infinitesimal displacement from this. The various expressions including Bryan's result are then deduced. The accepted formulæ for changes of curvature in terms of the corresponding changes in the stress couples need not be restricted to the case of shells where surfaces are free from stress, provided only that the changes under consideration are not accompanied by any change in the magnitude of the applied surface-tractions, which requirement is satisfied in the boiler-flue problem. From energy considerations Basset is right in saying that a complete expression for the potential energy will contain terms depending on π_1 and π_2, although he has not shown that these pressures, when their intensity remains constant, influence to any sensible extent the increase of energy involved in a slight displacement from the equilibrium configuration. The author, from his results, obtained independently of the theory of thin shells, inclines to the view that they will not. The methods are then applied to obtain an estimate of the effect of "collapse rings," which

tend to prevent distortion of the tube at its ends, and the consequent strengthening effect is investigated by consideration of displacement types in which the departure of the cross-sections from circularity varies in the axial direction. A curve drawn connecting pressure and length is found to be discontinuous, thus throwing interesting light upon Fairbairn's formula, which makes the collapsing pressure inversely proportional to the length of the tube, thereby showing that comparatively short tubes must have been considered, since the possibility of discontinuities is neglected. H. H. Ho.

1242. *Friction and Isochronism of the Double Spiral.* **J. Andrade.** (Comptes Rendus, 156. pp. 1218–1219, April 21, 1913.)—In a previous communication [see Abstract No. 1455 (1911)] the author has dealt with the law relating to the oscillations of a balance regulated by two spirals, each adjusted by Le Roy's method. Following this came an experimental study of the most favourable modes of grouping two spirals for reducing lateral friction. In the present note a valuable property of a double spiral having coincident loops is discussed. The pressure supported by the common loop is purely radial, but the resulting friction does not disturb isochronism. The advantages from the use of a double spiral, or of a couple made up of two double spirals are briefly described, as also its application to the problem of regulating a marine chronometer. H. H. Ho.

1243. *Properties and Structure of Ice.* **R. S. Tarr** and **J. L. Rich.** (Zeitschr. f. Gletscherkunde, 6. p. 225. Nature, 91. p. 307, May 22, 1913. Abstract.)—Experiments made with various kinds of ice (pond, granular, snow glacier) support the views of Mügge and McConnell against Tyndall and Moseley, who did not sufficiently allow for the time element. Ice welds readily at 0°; when a block has been cut by a wire, optical continuity is re-established after regelation; the welding at temperatures below the freezing-point leads to a structure resembling that of crushed marble. Plastic deformation does not appear to set in before a certain strain has been reached; the deformation and optical properties are influenced by the direction of the crystal; granular ice is also deformed. A cake of pond ice, 30 cm. thick, consisted of 10 cm. of fine granular ice (top), 15 cm. of coarse prismatic crystals at right angles to the water surface, and 5 cm. of granular ice with crystals of diverse orientation. H. B.

1244. *Shapes of Drops and Bubbles.* **A. Ferguson.** (Phil. Mag. 25. pp. 507–520, April, 1913.)—(1) In this paper methods are described by means of which approximations to the outlines of large bubbles and drops may readily be made. These differ slightly in their correcting terms from those obtained by other methods. (2) A mechanical or planimetric method of integration is also described which is applicable to drops and bubbles of all sizes. (3) The more frequent use of photography in such measurements is advocated, and (4) some experimental illustrations of the photographic method are given and five photographs reproduced. E. H. B.

1245. *External Friction of Gases.* **W. Gaede.** (Ann. d. Physik, 41. 2. pp. 289–336, June 3, 1913.)—(1) The flow of hydrogen through a narrow slit between two glass plates at pressures from 1 atmo. to 0·02 mm. was investigated: deviations from the theory of Knudsen are observed. (2) By investigations on the flow of gas mixtures it was made manifest that the friction between the gas and the wall of the chamber is influenced by the

formation of a *gas-skin*. The greater the total pressure of the gas mixture the more clearly marked is the gas-skin and the more does the external friction exceed the value to be expected on Knudsen's theory. (3) The flow of hydrogen and nitrogen through a capillary was investigated at low pressures down to 0·0002 mm. At pressures under 0·001 mm. the theory of Knudsen was satisfied, but not at higher pressures. Various other points were also dealt with. [See Abstracts Nos. 371 (1909) and 501 (1910).]

E. H. B.

1246. *Internal Friction of Rarefied Gases.* **A. Timiriazeff.** (Ann. d. Physik, 40. 5. pp. 971–991, April 29, 1913.)—Discusses the subject of internal friction in gases at low pressure, also the connection between "slipping" and the discontinuity of temperature at the boundary between metal and gas. [See Abstract No. 882 (1912).] A method of stationary deflections was used for a new investigation of the internal friction in the pressure interval 760 to 0·001 mm. of Hg. A theoretical investigation, based on the Maxwell-Boltzmann gas theory, is given, and the experimental results for air and CO_2 are in good agreement with the theoretical results. A. W.

1247. *Exceptional Collisions of Gas Molecules.* **P. Langevin** and **J. J. Rey.** (Le Radium, 10. pp. 142–145, April, 1913.)—The distribution of velocities being assumed to follow the Maxwell law, it is here shown that the number of collisions per sec. per unit volume which present a normal velocity component exceeding v is the fraction $e^{-hmv^2/2}$ of the total number of collisions. It is then calculated that, for air at ordinary temperature and pressure, and for collisions sufficient to dissociate the molecules,

$$h = 12{\cdot}5 \times 10^{12} \text{ and } \tfrac{1}{2}mv^2 = 3{\cdot}7 \times 10^{-12} \text{ erg.}$$

This number of ergs is of the order required for a corpuscle to ionise a molecule. E. H. B.

1248. *Coefficient of Diffusion for Gases according to O. E. Meyer.* **J. P. Kuenen.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1152–1156, May 30, 1913.)—The author discusses the various methods of deriving an expression for the coefficient of diffusion from the kinetic theory, on the assumption that the molecules behave like elastic spheres, with the object of finding why that of O. E. Meyer leads to a result differing largely from the others and from observation, although the fundamental assumptions are essentially the same. The deduction of Meyer's formula is given, and the remark made that according to it the coefficient of diffusion varies strongly with the composition of the mixture. The experimental evidence, however, is in favour of a coefficient which varies only to a very small extent, and therefore puts Meyer's formula out of the question. The coefficient of diffusion according to Stefan is independent of the composition of the mixture, and agrees approximately with experiment. The latter was proved by Langevin to follow from Maxwell's second theory when applied to elastic molecules, and the only simplifying assumption which Langevin had to make for carrying out the required integration was, that in ordinary slow diffusion Maxwell's law of distribution may be taken as fulfilled. The want of rigour which this implies may perhaps account for the small difference between the formula and observation. Several physicists have tried to account for the great difference between Meyer's result and the others. Gross criticised the superposition of the gas current on the diffusion current, and proposed

leaving out the former while modifying the latter. This, however, is certainly illegitimate, as the gas is presupposed to be at rest or the plane through which the diffusion streams is calculated to move with the gas. Langevin pointed out that Meyer took no account of dynamical action between the two kinds of molecules, but he, like Boltzmann, does not attempt the solution. Jeans has shown the possibility of removing the greater part of the contradiction by making use of the notion of persistence of molecular velocity, a notion which plays an important part in the theory of the Brownian movement. This quantity depends on the principle that when a molecule collides with other molecules, it will after a collision have retained on the average a component of velocity in the original direction. Jeans has shown that the usual calculations in the kinetic theory of the various transport-phenomena, of which diffusion is an example, have to be corrected for this persistence, but his modification of Meyer's formula does not effect any improvement, as the diffusion coefficient has merely been multiplied by a constant factor, and the anomalous dependence on the number of molecules remains. The author points out that Jeans has overlooked the important fact that the persistence obtains a different value when a mixture of two kinds of molecules of different mass is dealt with. By taking account of the latter point, the author finds the modified formula to agree practically with Stefan's expression. Since Jeans's method of calculating the persistence is not rigorous, it might perhaps be found possible by applying more rigorous methods to reduce the remaining difference between Meyer's corrected formula and the other one. The author points out that the method indicated in this paper can immediately be used to deduce rational formulæ for the viscosity and the conduction of heat for gas mixtures. H. H. Ho.

1249. *Brownian Movements of Particles not Spherical.* **K. Przibram.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2339–2350, Dec., 1912.)—As material the chains of dead *Bacillus subtilis* was used, the observations being made with a Siedentopf's cardioid condenser. The results are given in elaborate tables and graphically exhibited also. Some theoretical deductions the author was unable to confirm. [See Abstract No. 743 (1906).] E. H. B.

1250. *Inertia and Weight Masses in Relativity Mechanics.* **G. Nordström.** (Ann. d. Physik, 40. 5. pp. 856–878, April 29, 1913.)—A highly analytical treatment reaching the following conclusions:—The gravitational acceleration is less the greater the velocity is, but is independent of the direction of that velocity. Thus a horizontally-projected body falls slower than one starting vertically from rest. [See Abstracts Nos. 1086 (1911) and 29 (1912).] E. H. B.

1251. *Velocity Distribution of Air near Wire moving Lengthwise.* **K. Przibram.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2333–2337, Dec., 1912.)—Describes, but without a diagram, the arrangements for observing microscopically the motions in question. A logarithmic graph gives straight lines. E. H. B.

1252. *Principle of Least Action and Relativity.* **E. Henschke.** (Ann. d. Physik, 40. 5. pp. 887–934, April 29, 1913. Author's Dissertation, Berlin.)—A highly analytical treatment of the subject, being a continuation of a previous article [see Abstracts Nos. 2277 (1905), 1990, 1991 (1908), and 1537 (1911)]. E. H. B.

1253. *A Long-range Weather Forecast for the East Monsoon in Java.* **C. Braak.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1063–1069, May 30, 1913.)—The author has previously found that in the Indian Archipelago a connection is clearly perceptible between the barometric pressure and rainfall [see Abstract No. 356 (1913)]. In the present paper this connection is made use of for forecasting the rainfall in Java. A curve is reproduced showing the departures from normal of the air pressure in Port Darwin. This curve shows several series of well-marked 3-year waves separated by broken irregular periods, which latter are found to correspond to the maxima of the sun-spot curve. The connection is next considered between these regular pressure-waves and the West Java rainfall, and a set of laws which appear to govern the relationship between the two elements is drawn up. These laws are applied to the situation at the time of writing the paper, and it is concluded that most probably the East Monsoon in Java of 1913 will deviate in the wet, and that of 1914 probably in the dry, direction from the mean. J. S. Di.

1254. *The Unusual Atmospheric Haziness during the latter part of* 1912. **H. H. Kimball.** (Washington Acad. Sci., Journ. 3. pp. 269–273, May 19, 1913.)—A large amount of data was collected from the United States, Canada, and the North Pacific, and from this the conclusion is reached (1) that the meteorological conditions were especially favourable to the formation of haze, and (2) that the origin of some of the haze was to be found in the smoke from forest fires in Canada and British Columbia and in smoke or dust from Katmai Volcano. The haze was not observed in Europe and Northern Africa until about a fortnight later than in the United States. J. S. Di.

1255. *Exposure of Thermometers for the Determination of Air Temperature.* (Nature, 91, p. 361, June 5, 1913. Abstract of Report of Prussian Meteorolog. Inst., 1911.)—Thermometers exposed at a north window (formerly the usual method adopted in Germany) give readings in good agreement with those of an aspirated thermometer in the same neighbourhood. The true temperature in the shade on the north side of a building differs considerably from the temperature in an open field. At 2 p.m. in July the latter is 1° C. in excess, but the mean temperature for the day is not widely different in the two places. The afternoon readings in a Stevenson screen in North Germany tend to be slightly too high, 0·1–0·2° in winter, 0·2–0·4° in summer. The errors differ with different climates and with varying conditions of weather. J. S. Di.

1256. *Effect of the Atmospheric Turbidity of* 1912 *on Solar Radiation Intensities and Skylight Polarisation.* **H. H. Kimball.** (Mount Weather Observatory, Bull. 5. Part 5. pp. 295–312, 1913.)—The general nature of the effects have already been discussed [see Abstract No. 162 (1913)]. The present paper is devoted to a more detailed study. The radiation intensities measured at Madison, Wis., during the second half of 1912 averaged only 86 per cent. of the intensities measured in the corresponding period of 1910 and 1911. At Lincoln, Nebr., the intensities in Nov., 1912, averaged only 82 per cent. of the corresponding intensities in Nov., 1911. The percentage of polarisation of skylight with the sun at zenith distance 60° was also below the normal in the second half of 1912. A large increase in polarisation near the zenith was found to occur just after sunset similar to that in 1903, after the eruption of Mount Pelée. It has been found, both on the present

and on previous occasions, that periods of decreased solar radiation intensity have been accompanied and followed by a marked increase in the solar distance of Babinet's neutral point at about the time of sunrise and sunset.
J. S. Di.

1257. *Earth's Rotation Demonstrated.* **A. H. Compton.** (Science, 37. pp. 803-806, May 23, 1913.)—The two methods generally known for demonstrating the earth's rotation are Foucault's pendulum and the gyroscope, but the former requires a great height and the latter is very expensive. The method here detailed involves the use of a circular tube filled with water and placed in a plane perpendicular to the earth's axis. Then in the upper part of the tube the water is moving to the east with respect to the lower part. If the tube is quickly rotated through 180° about its east and west diameter, this action is reversed and can be detected by the motion of globules of linseed oil and oil of cloves of the same mean density as the water and which is observed by a micrometer microscope. E. H. B.

1258. *Elasticity of the Earth and the Earth's Crust.* **T. Shida.** (Coll. Sci. and Engin., Mem. Kyōtō, 4. 1. pp. 1–284, Nov., 1912.)—This monograph consists of six parts, and is largely of a tabular and graphic nature; no abstract is possible. The main divisions are: I. Horizontal pendulum observations of the change of plumb-line at Kamigamo. II. The atmospheric tide. III. [with **M. Matsuyama**] Hecker's observations of pendulums. IV. Paths and transit times of preliminary tremors of near earthquakes. V. Attempt to find the Chandler period of free nutation. VI. [with **M. Matsuyama**] Change of plumb-line referred to the axis of the earth as found from International Latitude Observations. L. H. W.

1259. *Expedition for the Observation of the Aurora Borealis at Bossekop in the Spring of* 1913. **C. Störmer.** (Comptes Rendus, 156. pp. 1871–1872, June 16, 1913.)—In this expedition, undertaken to complete the results of a previous one in 1910, 450 pairs of simultaneous successful photographs were taken from Bossekop and Store Korones, 27 km. apart. Photographs were also obtained of the spectral lines of stars superimposed on those of the aurora. Two plates accompany the article, one showing a 4-sec. exposure kinematograph record of an aurora. A detailed memoir is to follow. *Errata*, p. 2038, June 30, 1913. H. F. H.

1260. *On a Curious Aspect of the Third Satellite of Jupiter.* **J. Guillaume.** (Comptes Rendus, 156. pp. 1736–1737, June 9, 1913.)—On May 24, from Lyons Observatory, with a magnification of 365, Ganymede presented an oval shape, instead of its usual round disc; and a very white polar spot could be distinguished upon it, with a smaller grey zone below. A similar phenomenon, but less marked, had been observed before by the author in 1890 and 1893. The luminosity of each of the satellites I., II., and III. was sensibly the same, and normal. H. F. H.

LIGHT.

1261. *Thermal Microscope for Measurement of Optical Constants of Minerals at High Temperatures.* **F. E. Wright.** (Washington Acad. Sci., Journ. 3. pp. 232–236, April 19, 1913.)—With this new microscope three optical constants —birefringence, extinction angle, optic axial angle—of a properly oriented crystal plate can be measured accurately at any temperature between 10° C. and 1200 C. Above 1200° C. the intensity of illumination from the furnace itself is so great that it tends to veil the optical phenomena produced by the polarised light-waves transmitted through the plate. The thermal microscope consists of two parts: (i) a petrographic microscope equipped with a suitable device for simultaneous rotation of the nicols, either by means of gear-wheels connected by a bar or by means of a direct connecting bar, the second method being the more accurate and satisfactory; (ii) an electrical resistance furnace which is enclosed within a water-jacket. Constructional details of the furnace are given; the temperature measurements are made by means of a thermo-element in contact with the mineral plate, which is held in position by Pt jaws. Particulars are given of the method of adjustment of the crystal plate and of the methods of determining the three constants above mentioned. A. W.

1262. *Strioscope and Interferential Striograph.* **G. Sagnac.** (Journ. de Physique, 3. Ser. 5. pp. 81–89, Feb., and pp. 292–305, April, 1913.)—Two prisms, whose dihedral obtuse angles are a little less than 120°, are placed with their larger faces together, but separated by a thin film of air. Parallel light incident on one of the smaller faces is partly reflected and partly transmitted by the air film between the two prisms, and the reflected and transmitted portions traverse in opposite directions an approximately rectangular path, being reflected from plane mirrors at the corners, and being finally reflected and transmitted respectively by the air film. In the striograph a photographic apparatus receives the beams twice reflected and twice transmitted respectively by the air film. In the strioscope an eyepiece replaces the photographic apparatus. A polariser is used to give light polarised either parallel or perpendicular to the plane containing the central ray, and the apparatus is adjusted so as to give, for a certain wave-length, equality of amplitude of the reflected and transmitted beams. Owing to the perfect transparency of the air film there is rigorous opposition of phase of the two beams, and so with monochromatic light the central fringe is enlarged indefinitely and the field of interference is uniformly dark. The appearance of the field is described when various objects are interposed; the hot air rising from the fingers of the hand gives rise to very bright bands, an action much too strong to give an idea of the sensibility of the method. Theory is given, and the method of adjustment described. An apparatus of small dimensions is obtained by replacing one of the triangular prisms by one whose section is a parellelogram, having thus a face parallel to the air film at which the light is totally reflected internally, and which thus replaces one of the plane mirrors of the larger apparatus. The other two mirrors are replaced by two faces of another triangular prism. An example of the use of the apparatus is given in a study of the action of a helix on a gaseous jet. A. W.

1263. *Gelatine Colour-filters for Mercury Lamps.* **H. Schulz.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 286–289, April 30, 1913.)—Describes the results obtained by passing the light from a mercury lamp through a series of colour-filters. The filters isolate the lines 579 + 577 $\mu\mu$, 546 $\mu\mu$, 436 $\mu\mu$, 407 + 405 $\mu\mu$, and 365 $\mu\mu$; they are prepared by C. P. Goerz. A. W.

1264. *Elastic Deformation and Selective Absorption.* **P. Selényi.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 290–291, April 30, 1913.)—Gives an account of experiments made with the object of ascertaining whether pressure applied to a ruby, cut perpendicular to the optic axis, had any effect on the absorption spectrum. Pressures up to about 150 kg./mm.^{2} were employed, but no positive result was obtained. The experiment was carried out at liquid-air temperature, at which H. du Bois has shown [Abstracts Nos. 1108 (1908) and 67 (1909)] that the absorption spectrum of ruby exhibits very fine lines. [See also Abstract No. 838 (1902).] A. W.

1265. *Effect of Reflection from a moving Mirror on the Velocity of Light.* **A. A. Michelson.** (Astrophys. Journ. 37. pp. 190–193, April, 1913.)—According to the undulatory theory of light the velocity of light is independent of the velocity of the source, and of the velocity of a mirror at which it is reflected. According to the emission theory the resultant velocity from a moving source is increased by the component of the velocity of the source. But it appears that different forms of emission theory require different results on reflection from a moving mirror. If the light-corpuscles are reflected as projectiles from an elastic wall, then the velocity of light should be increased by twice the component of the velocity of the mirror [Abstract No. 56 (1913)]. The following arrangement was devised for the purpose of deciding the question experimentally. Light from a source S falls at 45° incidence on a lightly silvered mirror A. The reflected pencil goes to a mirror D, thence to a concave mirror E, to a second mirror C (revolving about the same axis O as the mirror D), whence it proceeds to a plane mirror B, and is reflected back to A. The pencil transmitted by A follows the same path in the opposite direction, returning via DA to the starting-point, where it meets the first pencil, producing interference fringes which are observed by means of a telescope with micrometer eyepiece. Theory shows that the displacement Δ of the fringes seen in the telescope is given by $\Delta = 4D(2 - r)v/\lambda V$, where D is the distance OE, V is the velocity of light, v the component of the velocity of the mirror in the direction of the reflected pencil, and $r = 2$ according to the elastic impact theory, $r = 1$ if the mirror surface acts as a new source, while $r = 0$ on the undulatory theory. The experiment was tried under the following conditions: The revolving mirrors were mounted on the shaft of an electric motor, the speed of which could be varied from zero to 1800 r.p.m. The distance l between the centres of the mirrors was 26·5 cm., and the distance OE was 608 cm. Light of mean wave-length 0·6 μ was used. The displacement formula for $r = 0$ becomes $\Delta = 8\pi Nl D/60\lambda V$, where N is the number of turns per min., and on substitution of the above values, putting $N = 1000$, Δ was found to be 3·76. The mean value of the observed displacement was 3·81. Hence it appears that within the limit of error of experiment (say 2 %) the velocity of a moving mirror is without influence on the velocity of light reflected from its surface. Assuming that the effect is actually nil, this interference method may be used to measure the velocity of light with an order of accuracy equal to that of the improved Foucault method, or of the "combination" method [Abstract No. 1508 (1902)]. Any one of these three

methods is capable of furnishing results of the order of accuracy of 1 in 10^5; and differential measurements (*e.g.* with the light of the two limbs of the sun) can be obtained with a still higher degree of precision; thus the effect of a moving source on the velocity of light could be determined. A. W.

1266. *Refractive Indices of Gases under High Pressures.* II. *Dispersion of Air and of Carbon Dioxide.* **L. H. Siertsema.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 925–931, April 24, 1913.)—The measurements on these two gases were made exactly as with hydrogen [see Abstract No. 301 (1912)]. The dispersion constants for air were found to be the same for all pressures up to about 100 atmos., their values being as follows :—

$\lambda =$ 0·644	0·546	0·509	0·472	0·436	0·405
0·9945	1	1·0030	1·0067	1·0114	1·0166

These results, which are tabulated together with those of other observers, can be expressed by the formula—

$$c = (n-1)/(n_b-1) = 0{\cdot}98086(1 + 0{\cdot}0056376/\lambda^2 + 0{\cdot}00005401/\lambda^4).$$

With carbon dioxide the dispersion is independent of the pressure up to the saturation pressure. The results obtained are as follows :—

$\lambda =$ 0·644	0·546	0·509	0 472	0·430	0·405
0·9937	1	1·0034	1·0074	1·0126	1·0181

The interpolation formula expressing these values is—

$$c = (n-1)/(n_b-1) = 0{\cdot}97781(1 + 0{\cdot}0067868/\lambda^2 - 0{\cdot}00000614/\lambda^4),$$

which is in good agreement with the theoretical dispersion formula; the wave-length *in vacuo* is calculated to be 0·07982 μ. T. H. P.

1267. *Electric Double Refraction.* **C. Gutton.** (Comptes Rendus, 156. pp. 1370–1373, May 5, 1913.)—In a previous paper [Abstract No. 1131 (1913)] the author has shown that the variations of electric double refraction of liquids do not follow instantaneously the variations of the electric field. The present paper describes the method of determining the time required for the establishment of electric double refraction. The arrangement of apparatus was the same as for the earlier experiments. By charging the condensers with Hertzian waves of lower and lower frequencies, a point is reached at which the compensation, already established for static charges, holds good for the oscillatory charges. The variations of intensity of the electric field are then slow enough to allow the double refraction of the two liquids to reach their normal values. The time of charging of the condensers being equal to the time during which the Hertzian waves travel $\frac{1}{4}$ wave-length, the measurement of this wave-length serves to determine the time required to establish double refraction in the liquid whose double refraction follows less quickly the variations of intensity of the electric field. The electric oscillations were produced by oscillators of the Lecher type, the smallest being completely immersed in vaseline, and a Tesla transformer was used. The Hertzian waves were led to the condensers by wires 16 m. long, in which the position of the internodes of the stationary waves obtained by reflection from the ends could be observed. Using naphthalene bromide and carbon disulphide it was found that with oscillations of half wave-length 850 cm., there was compensation for oscillatory as well as for static charges. For half wave-length 95 cm. the distance apart of the plates of one

of the condensers had to be diminished by 8·5 %, this diminution being smaller and smaller as the half wave-length was increased to 850 cm. From this it is deduced that the time required for the establishment of electric double refraction in carbon disulphide is $1{\cdot}4 \times 10^{-8}$ sec. Other experiments give for toluene the value $1{\cdot}7 \times 10^{-8}$ sec., and for naphthalene bromide $0{\cdot}6 \times 10^{-8}$ sec. These results are of the order of magnitude required by the theory developed by Langevin, according to which the phenomenon is the result of molecular orientation. A. W.

1268. *Measurement of Wave-length Differences.* **P. P. Koch.** (Ann. d. Physik, 41. 1. pp. 115–123, May 22, 1913.)—Gives first a discussion of Priest's method of measurement [Abstract No. 334 (1910)], which differs from the method previously adopted with the Fabry and Perot interferometer [Abstract No. 1969 (1908)]. A photometric method is then described, in which use is made of the effect of a weak magnetic field on the red Cd line λ6439. [See also Abstracts Nos. 1192 (1912) and 410 (1913).] A. W.

1269. *Optical Constants of Sodium and Potassium.* **R. W.** and **R. C. Duncan.** (Phys. Rev. 1. Ser. 2. pp. 294–308, April, 1913.)—It was found possible to obtain, and preserve indefinitely, bright surfaces of both Na and K by melting the metal in an evacuated chamber of special construction, and allowing the metal to solidify in a small capsule with plane glass ends, the opening being finally closed with paraffin. The experiments described show that metallic Na has the lowest index of refraction and the highest reflecting power of any metal known. This is in agreement with Drude's observations. The value of the refractive index for Na light is very near the upper limit (0·054) set by Drude. The values of the optical constants for (1) Na and (2) K were found to be—

	λ.	n.	κ.	Φ.	Ψ.	R.
(1)	6650	0·051	55·0	72° 11′	44° 29′	97·7
	5893	0·044	55·0	68° 51′	44° 29′	97·1
	5460	0·052	42·6	68° 48′	44° 20′	96·5
	4720	0·057	33·3	66° 29′	44° 9′	95·2
	4350	0·058	31·7	66° 0′	44° 6′	94·8
(2)	6650	0·066	26·8	65° 27′	43° 56′	93·8
	5893	0·068	22·1	62° 58′	43° 42′	92·0
	4720	0·070	14·3	57° 9′	43° 0′	86·9

The curve connecting n and λ for Na shows a distinct minimum near the D-line. Next to Na, K has the lowest index of any metal. Its reflecting power, however, is slightly less than that of either Ag or Na. A. W.

1270. *Dispersion of Metals.* **L. P. Wheeler.** (Amer. Journ. Sci. 35. pp. 491–508, May, 1913. Phil. Mag. 25. pp. 661–679, May, 1913.)—From an examination of the available data on the dispersion of Ag, Cu, Au, Ni, and Co, it is concluded that the inaccuracies in the experimentally determined values of the optical constants of these metals are too great to allow of much dependence to be placed on them except for *relative* values. These uncertainties limit seriously the information to be derived from the measurements, and suggest the desirability of obtaining data on the dispersion of Hg, for

which metal the causes of the inaccuracies can be eliminated. From a comparison of the data with the dispersion formulæ yielded by the electron theory, it appears—(i) That the number of free electrons is not a constant, but increases with the frequency of the currents set up by the incident radiation; slowly and uniformly in the infra-red, and more rapidly in the regions where the metals are more transparent. The explanation of this phenomenon is so involved with that of the mechanism of metallic absorption in general, that a wholly satisfactory elucidation of it seems to be impossible at the present time. (ii) That the dispersion of the so-called dielectric constant for these metals can be determined. It is seen to consist of two parts, of which that which depends on the presence of free electrons is more important than the other or pure dielectric term, especially at the shorter wave-lengths. It also appears that the form of the dispersion curves found is not inconsistent with that demanded by theory, although the inaccuracies of the data do not permit a satisfactory investigation of this point. [See also Abstracts Nos. 1339 (1903) and 359 (1912).] A. W.

1271. *Trend of Geometrical Optics.* **S. P. Thompson.** (Optical Convention, Proc. 2. pp. 297–304, 1912. Phys. Soc., Proc. 24. pp. 359–367, Oct., 1912. Abstract.)—With the exception of the formation of images upon the retina of the eye, and the system proposed by Biot and Bosscha, and adopted by Cornu and Sissingh, the method of Gauss for the treatment of lens systems by means of points and planes, as amplified by Listing and Toepler, and further developed by Blakesley, is now universally accepted, and the author points out its applicability to the solution of many lens problems. The need for improvement in defining the different uses of the terms *magnification, positive* and *negative*, is suggested, as also for suitable English equivalents for the German terms *Scheitel, Schnittweite, Durchbiegung, Durchrechnung, Abbildung. Porrhallaxie.* W. H. Si.

1272. *Polarisation of Light by Internal Diffusion.* **G. Dimmer.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 1517–1538, Oct., 1912.)—This is the fifth of a series of communications on the above subject; it is partly theoretical and partly experimental, the results being summarised in seven tables and eleven diagrams showing a number of graphs co-ordinating percentages of light polarised and angles. [See Abstract No. 1025 (1912).] E. H. B.

1273. *Demonstration of Spectrum Colours.* **M. Siegbahn.** (Phys. Zeitschr. 14. p. 412, May 1, 1913.)—Photographs of spark spectra may be shown in their original colours by using the apparatus with which they were taken, or some apparatus giving the same dispersion, for projection. A direct-vision spectroscope is most convenient. The slit is placed in contact with the lantern condenser. The continuous spectrum of the arc then illuminates the diapositive in the proper colours, and the image of the diapositive, thus coloured, is projected on a screen by another lens. E. E. F.

1274. *Arc and Spark Spectra of Calcium.* **O. Holtz.** (Zeitschr. wiss. Phot. 12. pp. 101–121, May, 1913.)—Describes measurements of the wave-lengths of the lines in the arc and spark spectra of Ca in international units. The results are tabulated and compared with previous measurements. The wave-lengths are given of the lines in three groups of chloride bands. A. W.

1275. *Effect of Self-induction on the Spark Spectra of certain Non-metallic Elements.* **G. V. Morrow.** (Roy. Dublin Soc., Proc. 13. 39. pp. 607–620, May, 1913.)—The spectra of the following substances were examined, using both gold and carbon electrodes, with and without self-induction: N, O, H, Cl, Br, I, S, P, BCl_3, $SiCl_4$, SO_2, H_2S, CO_2, CO, and HCl. It was found that sparking between electrodes in an atmosphere of any kind gives the principal lines of the line spectra of the elements present in the atmosphere, and as a rule with greatest intensity when self-induction is not introduced. In the case of hydrogen, the only electro-positive gas examined, the effect of self-induction is to intensify and sharpen the H lines, and to remove, or nearly so, the lines of gold or carbon; whereas, in the case of electro-negative gases such as O and N, the effect of self-induction is to remove, or almost entirely remove, the spectra of these gases, the gold and carbon alone showing. With elements such as Cl, Br, and I, the effects of self-induction are not so pronounced. In the case of carbon the effects of self-induction are pronounced and very remarkable. First, with self-induction, the three bands attributed to cyanogen are seen clearly defined in almost any atmosphere except H, but without self-induction only the one band at λ3883·6 is seen, and it also is seen in any atmosphere except H. Adopting the theory of Schuster and Hemsalech, that the current is conveyed across the gap at first by the air when there is no self-induction, it is concluded that under these conditions the temperature is too high for cyanogen to be formed by the carbon electrodes and any trace of N present. If this be so, the band which remains when self-induction is absent is probably due to carbon and not to cyanogen. [See also Abstract No. 853 (1912).] A. W.

1276. *Absorption of Light by Water changed by Presence of Strongly Hydrated Salts.* **J. S. Guy, E. J. Shaeffer** and **H. C. Jones.** (Amer. Chem. Journ. 49. pp. 265–286, April, 1913. Phys. Zeitschr. 14. pp. 278–288, April 1, 1913. Chem. News, 108. pp. 26–29, July 18, and pp. 37–41, July 25, 1913.)—By means of the radiomicrometer it has been shown that water containing strongly hydrated salts such as the chlorides of magnesium, calcium, and aluminium is more transparent than pure water, and that the band is shifted towards the region of longer wave-lengths. The suggestion is made that the water combined with the salt has a smaller absorptive power than free uncombined water. T. M. L.

1277. *Absorption of Light by Inorganic Salts.* VII. *Aqueous Solutions of Iron-Salts.* **J. S. Anderson.** (Roy. Soc. Edinburgh, Proc. 33. pp. 35–43, 1912–1913.)—The absorption-bands in the visible spectrum shown by solutions of ferric chloride in alcohol do not occur in the aqueous solutions, but the infra-red band at about 1 μ is very marked in the case of the chloride, nitrate, and sulphate, increasing in height and moving towards the visible region on dilution; in the case of the bromide the band shifts in the same direction, but the height increases on dilution. The general absorption in the visible region increases on dilution in the case of ferric nitrate and sulphate, decreases in the case of the bromide, and first decreases and then increases in the case of the chloride. This last increase of absorption in dilute solutions is more marked after keeping, and is perhaps due to the formation by hydrolysis of colloidal ferric hydroxide. T. M. L.

1278. *Absorption of Light by Inorganic Salts.* VIII. *Alcoholic Solutions of Copper, Cobalt, and Nickel Salts in the Ultra-violet.* **A. R. Brown.**

(Roy. Soc. Edinburgh, Proc. 33. pp. 44–48, 1912–1913.)—The absorption of light by copper chloride and copper bromide in the extreme ultra-violet is much increased by changing from aqueous to alcoholic solutions. The changes observed on increasing the concentration of nickel chloride in aqueous solutions are carried still further by dissolving in alcohol : they are therefore probably caused by dehydration. T. M. L.

1279. *Theory of Band Spectra.* **J. Stark.** (Phys. Zeitschr. 14. pp. 454–456, May 15, 1913.)—A reply to the criticisms of Burger and Koenigsberger [Abstract No. 597 (1913)]. The emission of band spectra is not necessarily conditioned by a total splitting-off of valency electrons. The latter is only a special case. The absence of the Zeeman-effect in band spectra is no objection to their electronic origin. It only means that the force maintaining the electron in its orbit is not directly proportional to the distance from the attracting centre. It cannot, in fact, be that, or the electron could not be split off. Valency electrons may absorb light without ionisation taking place. They may hand on the energy received to other constituents of the atom. E. E. F.

1280. *Vacuum-tube Discharge in a Magnetic Field.* **N. A. Kent** and **R. M. Frye.** (Astrophys. Journ. 37. pp. 183–189, April, 1913.)—Describes an investigation of the changes which take place in the spectrum of the vacuum-tube discharge when placed in a magnetic field. A brief *résumé* of previous work is given and photographs are reproduced. A Hilger single-prism spectrograph was employed, and fields up to 25,000 gauss were obtained with a Weiss electromagnet. The vacuum-tube discharge is certainly a complex phenomenon, owing to the large number of variables to be considered—potential, current, resistance, temperature, pressure, frequency, and composition of the gaseous mixture contained in the tube. The magnetic field has a decided effect. Ordinarily, in a given tube, the size of the capillary is constant, but the magnetic field, by forcing the ions to use only a small part of the capillary, virtually changes the effective cross-section. This increases the resistance of the tube, and diminishes the value of the current flowing. Secondly, the mechanical bombardment of the walls of the tube by the ions liberates material from the glass and adds to the complexity of the gaseous mass under investigation ; and, thirdly, these same collisions are probably one of the factors which result in the decomposition of the bombarding ions into simpler forms. In general, then, these three factors result in (*a*) the production of spectra either of substances already present in the tube as impurities or of dissociation products either (*b*) of the original gas or (*c*) of the glass. Examples of these are seen in (*a*) the enhancement of the hydrogen lines in an argon tube (which contained hydrogen as an impurity) when the tube was subject to the proper conditions ; (*b*) the change from the band to the line spectrum of nitrogen or the production of the oxygen spectrum in a carbon-monoxide tube ; and (*c*) the production of not only the sodium but the oxygen spectrum from the glass. Some peculiar phenomena were observed with a nitrogen tube. A. W.

1281. *"The Red Lithium Line."* **P. Zeeman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 1130–1131, May 30, 1913. Phys. Zeitschr. 14. pp. 405–406, May 1, 1913.)—Magnetic fields only resolve spectrum lines belonging to pair series or to threefold series into complicated types, *i.e.* not into triplets. The cause of the complicated resolution is intimately

connected with the presence in the spectrum of natural groups of two or three lines (series-doublet or series-triplet). It has nothing to do with the distribution of lines in series, for there exist connected series of lines, which are resolved into triplets by magnetic fields [see Abstract No. 617 (1908)]. Lines belonging to a very close series-triplet or series-doublet have recently [see Abstract No. 419 (1913)] been found by Paschen and Back to influence each other in a very peculiar manner. When a sufficiently strong magnetic field is applied, a normal triplet is seen instead of an expected superposition of the types of separation of the compounds. Lithium was one of the metals investigated by Paschen and Back, and on analogy with the other alkali metals it might be expected that the Li lines are very close pairs, although opinions have been expressed that the laws for the other alkali metals do not apply to Li. The author investigates the problem of finding whether the Li lines are really very narrow pairs or not by means of a method previously described. Inside the glass tube a small iron or copper vessel is placed to prevent the action of heated lithium on the glass. The observations were made in the second-order spectrum of a large Rowland grating. The red of the second order is superposed on the blue of the third order, so that the line 6708 is seen in the absorption spectrum as a blue line. With small vapour density the line resolved into two components, thus establishing the expected analogy with the other alkali metals. That component of the double line having the smaller wave-length appeared the most intense. The distance between the components was much smaller than that calculated from the empirical rule for elements of the same family. H. H. Ho.

1282. *Zeeman-effect.* **F. Paschen** and **E. Back.** (Ann. d. Physik, 40. 5. pp. 960–970, April 29, 1913.)—A continuation of previous work [Abstract No. 419 (1913)]. The oxygen triplet λ3947 was studied with still higher fields—ranging up to about 40,000 gauss. The research shows, from the marked definition of the parallel oscillating mean component of the resulting triplet, and the exact normal displacement of the mean perpendicular oscillating side components, such a close approximation to the normal Zeeman triplet that it can be concluded that the magnetic conditions employed yield the exact normal triplet; thus the author's theory is confirmed. The hydrogen lines H_α and $H\beta$ were also investigated for fields between 14,000 and 32,000 gauss. The general appearance of the Zeeman triplets of these lines was about the same as in weaker fields. The width of the side-lines was found to be the same as that of the polarised or unpolarised mean component. The diminution of the specific displacement $Z(=\Delta\lambda/\lambda^2 H)$ with increasing fields does not seem to agree with the discussion of Voigt [see Abstract No. 806 (1913)]. The equal breadth of the side and mean components of the triplets are not compatible with the first part of Voigt's discussion. On the other hand, it should be noted that the incomplete polarisation of the mean component can be explained by the theory. Also the independent development of the parallel and perpendicular oscillating components, of which the oxygen triplet gives a further example, is in agreement with one of Voigt's suppositions. A. W.

1283. *Aluminium Lines in Canal Rays.* **J. Stark, R. Künzer,** and **G. Wendt.** (Preuss. Akad. Wiss. Berlin, Ber. 14. pp. 430–441, 1913.)—It has previously been shown that certain series of He are associated with the He positive singly-charged atomions, and that others are associated with the positive doubly-charged atomions [Abstract No. 982 (1913)]. In the present

paper it appears that Al exhibits similar properties, and gives evidence of the existence in front of the kathode of singly-, doubly-, and trebly-charged ions, with three corresponding velocity-intervals. With a kathode fall of potential of less than about 8000 volts, the singly- and doubly-charged Al-ions preponderate over those trebly-charged; with a kathode-fall of over 8000 volts the number of trebly-charged Al-ions is considerably greater than that of the singly- and doubly-charged ions. The singly-, doubly-, and trebly-charged ions are the carriers of different spectral lines. To the spectrum of the singly-charged ions belongs the doublet λ3961·7, λ3944·2; to that of the doubly-charged ions the line λ4663·5; to that of the trebly-charged ions the lines λ4529·7, λ4513·0 and λ4480·0. A. W.

1284. *Fluorescence Spectrum of Iodine Vapour.* **J. C. McLennan.** (Roy. Soc., Proc. Ser. A. 88. pp. 289–296, May 8, 1913.)—The three lines 5460·74, 5769·60, 5790.66 of the Hg arc used by Wood in his work on resonance spectra [Abstracts Nos. 42 (1912) and 801 (1913)] are among the strongest in the Hg arc spectrum. The object of the present research was to detect, if possible, resonance or fluorescence spectra excited by other Hg lines, especially the stronger lines in the ultra-violet region. The tube used consisted of two parts, the outer part being made of glass of the ordinary Cooper Hewitt design, and the second part consisting of a tube of clear fused quartz extending well inside the glass tube and sealed into it by wax joints. The glass tube was furnished with Hg terminals and carried the Hg arc. Iodine in crystals was inserted in the quartz tube, which was then highly exhausted and afterwards sealed off. Thus the iodine vapour in the tube was subjected to intense illumination by light of wave-lengths extending beyond λ7000 and down to about λ1850. Examination of the light issuing from the exposed end of the quartz tube showed in addition to the ordinary Hg lines a number of narrow bands extending from about λ4600 to about λ2100. Photographs reproduced show a set of seven well-marked bands between λ3341·7 and λ3131·7 and also sets approximately equally spaced on either side of the line λ4358·3. A limited series of bands in pairs is distinguishable between λ3131·7 and λ2893·7, and a number of single bands can be seen between λ2893·7 and λ2536·7. Below λ2536·7 the bands are spaced at intervals of approximately 20 Å. and extend to the limit of the photograph. A wave-length table of the heads of over 80 bands is given, from λ4608 to λ2129. With no iodine in the tube no bands could be observed, as was also the case when a tube of ordinary combustion glass was substituted for the quartz tube. It seems probable, therefore, that the emission of the band spectrum is a true resonance effect stimulated by the light from one or more lines in the Hg arc spectrum (doubtless in the ultra-violet region) to which the combustion glass tubing is not transparent. Up to the present it has not been possible to pick out, with any certainty, the lines which give rise to the new resonance spectrum, but experiments with this end in view are in progress. Explanations are given of the non-appearance of the lines of the Wood resonance spectra on the photographs. The conditions are favourable for the absorption of the lines of the Wood spectra. A. W.

1285. *Magnetic Spectrum of β-rays from Radio-Actinium.* **O. v. Baeyer, O. Hahn,** and **L. Meitner.** (Phys. Zeitschr. 14. pp. 321–323, April 15, 1913.)—A preparation of radio-actinium was obtained in great purity by repeated precipitation with ammonium thiosulphate. It was finally deposited electrolytically on silver wires 0·15 mm. thick from an HCl solution. Such a

preparation corresponded radio-actively to 0·05 mgm. RaBr. The magnetic spectrum was obtained as before [see Abstracts Nos. 1963 (1908), 245 (1912)], the exposure being 9 hours. In that time not more than 3·5 per cent. AcX and of its disintegration products were formed. The photograph (reproduced) shows 7 distinct groups of β-rays, whose velocities are 0·73, 0·67, 0·60, 0·53, 0·49, 0·43, and 0·38 respectively of the velocity of light. There is also an indication of unreflected rays. Further experiments with much stronger fields (4000 to 5000 gauss) show them to be γ-rays. E. E. F.

1286. *X-ray Fluorescence.* **W. Kaufmann.** (Phys. Zeitschr. 14. pp. 386–387, May 1, 1913.)—Confirms E. A. Owen's rule [Abstract No. 1197 (1912)] that the absorption of fluorescent X-rays in gases is inversely proportional to the fifth power of the atomic weight of the emitting metal, and extends it to a list of twenty substances. The rule applies so long as the emitting metal and the metal contained in the absorbing gas is not the same. E. E. F.

1287. *X-ray Luminescence of Mercury Vapour.* **St. Landau** and **H. Piwnikiewicz.** (Phys. Zeitschr. 14. pp. 381–386, May 1, 1913.)—Hg vapour fluorescences under the influences of X-rays. The fluorescence increases with the density of the vapour, and is reduced by the presence of other gases. The increase of the luminous intensity is not simply due to increase of temperature. The spectrum is a continuous one. E. E. F.

1288. *Some Relations between Kathode and Röntgen Rays.* **R. Whiddington.** (Röntgen Soc., Journ. 9. pp. 23–28; Discussion, pp. 29–31, April, 1913.)—The need of some practical and precise method of defining the quality of a beam of Röntgen rays has long been felt, and various proposals have at different times been put forward and submitted to the test of experiments. None of the methods at present in use are satisfactory. The mode of definition now proposed has the advantage that only one observation is required, and this can be made in a few seconds. From the theoretical standpoint the method is very fundamental. The proposal is to express the quality of Röntgen rays in terms of the speed of the kathode rays striking the target within the focus tube. The apparatus consists essentially of a magnetic field arrangement to sift out kathode rays of a definite velocity from the heterogeneous bundle usually obtained when a coil is used with a soft tube, and allowing this sifted beam to fall on an antikathode. The Röntgen rays so produced can then be examined in the usual way with ionisation chamber and electroscope. It is found that so long as the speed of the particles striking the antikathode does not exceed a certain critical value (depending on the material of the radiator) there is hardly any ionisation in the ionisation chamber, but if the speed exceed this critical value there is a strong ionisation. Barkla has shown that with each element is associated a fluorescent radiation. If at this critical point the velocity of the kathode rays striking the antikathode is measured, then it is known that rays moving with this velocity emit Röntgen rays of slightly greater penetrating power than the fluorescent radiation of the element of which the radiator is composed. This critical speed is measured for several elements, and the results are given in tabular form. From these results the important conclusion is drawn that in order to excite fluorescent radiation characteristic of the element of atomic weight A, a focus bulb in which the kathode rays are moving with a speed of at least $A \times 10^8$ cm./sec. must be used. Thus in order to define at any instant the Röntgen rays all that is necessary is to determine the velocity of the kathode

rays by a magnetic deflection method. If in addition the absorption coefficient in aluminium of the rays is required no additional measurements are necessary ; the table given indicates the value of the absorption coefficient of the hardest rays emitted by the bulb, and it is shown that the quality of any beam of Röntgen rays is completely defined by determining the quality of its hardest component. **A. A. Campbell-Swinton.** (Nature, 91. p. 425, June 26, 1913.) A. E. G.

1289. *Reflection of X-rays.* **J. Stark.** (Phys. Zeitschr. 14. pp. 319–321, April 15, 1913.)—In connection with the explanation of the "diffraction" effects observed by Friedrich, Knipping and Laue [Abstract No. 1153 (1913)], as affected by the observations of Bragg and of Barkla and Martyn [Abstracts Nos. 604 and 180 (1913)], the author modifies his original hypothesis [Abstract No. 182 (1913)] and emphasises the selective scattering of X-rays rather than their selective absorption. The phenomenon is analogous to reflection from a somewhat rough surface at grazing incidence. Interference, if produced, would take place on the plan of Newton's rings. E. E. F.

1290. *X-ray Interference Phenomena in Non-crystalline Bodies.* **W. Friedrich.** (Phys. Zeitschr. 14. pp. 317–319, April 15, 1913.)—Interference phenomena somewhat analogous to those obtained in crystals by Knipping, Laue, and the author [Abstract No. 1153 (1913)] are also obtained with some amorphous bodies. Soft wax shows several concentric rings (reproduced). Canada balsam, paraffin, paraffin oil, amber, and meerschaum show indications of rings, or at all events a distribution of intensity suggestive of diffraction. The author suggests that these rings are analogous to haloes, and that the scattering bodies are atoms, irregularly distributed. The wave-length of the X-rays would in that event have to be 10^{-9} cm. That it is an atomic phenomenon is suggested by the fact that the behaviour of liquid and solid paraffin is nearly the same. When wax is compressed in a direction normal to the rays, the rings disappear in a direction normal to the line of compression. E. E. F.

1291. *Peripheral Effect with X-rays.* **W. F. D. Chambers** and **I. G. Rankin.** (Nature, 91. p. 397, June 19, 1913.)—Whilst repeating the now well-known experiments of Barkla, Laue, and others, the authors accidentally met with the following effects. By inadvertence the edge of a piece of mica intercepted a direct beam of X-rays, and the recording photographic plate showed pronounced black and white bands along the X-ray shadow of the edge of mica. Further experiments with mica, glass, and metals also gave the effect, the edge of the shadow being bounded by a well-defined black band in the dark portion of the field with a light band in the lighter half. The metals tried and giving bands include lead, iron, zinc, copper, and aluminium. E. H. B.

1292. *Reflection of X-rays.* **M. Laue.** (Phys. Zeitschr. 14. pp. 421–423, May 15, 1913.)—Discusses the various alternative theories advanced by Stark, Bragg, Mandelstam, Rohmann, and others [see Abstracts Nos. 266, 604, 990–995 (1913)]. The author sees in none of these a refutation of the interference theory. The most formidable argument against the latter lies in the small effect of heat, but this applies also to the rival theories. Apart from this, the interference theory of X-ray patterns means only an extension of the ordinary theory of the grating to the case where the grating element is large compared with the wave-length. E. E. F.

1293. *Vibration Frequency of X-rays.* **G. Zemplén.** (Phys. Zeitschr. 14. pp. 423–424, May 15, 1913.)—The discovery of interference patterns due to X-rays [Abstract No. 1153 (1913)] puts the X-ray wave-length between 1 and 5×10^{-9} cm., say 3×10^{-10} cm. This means a frequency of 10^{19}. On Planck's theory of quanta, the elementary quantum of energy conveyed by X-rays should therefore be $6{\cdot}55 \times 10^{-8}$ erg. This can be controlled by W. Wien's data concerning the efficiency of transformation of kathode rays into X-rays, which amounts to about 1 in 1000. Now the energy of a kathode-ray particle is its charge multiplied by the p.d., both in e.s. units. It is about 8×10^{-8}, so that if $\frac{1}{1000}$ of this appears as an energy quantum of X-rays, we shall get the quantum 8×10^{-11}, which is some 800 times smaller than is required by the quanta theory. The latter can be saved by assuming that only one electron in a thousand gives rise to an X-ray pulse, or by some other assumptions, none of which, however, are entirely approved by the author. E. E. F.

1294. *X-ray Diffraction in Gypsum.* **J. Herweg.** (Phys. Zeitschr. 14. pp. 417–420, May 15, 1913.)—Gypsum has two cleavages with which specially simple diffractions are obtainable. They are the "silky" and the "shell" cleavage. If a fine pencil of X-rays falls on to one of these cleavage planes, making an angle of about 10° with it, a number of spots are obtained, some transmitted, some reflected, all lying on the circumference of the same circle (reproduced). The same phenomenon is obtained with an ordinary grating by allowing a beam of light to fall upon it grazingly in the direction of the rulings. The author shows that the observation can be simply and accurately explained on the interference theory. He suggests that this method may be useful for determining crystalline angles in the absence of natural angles. E. E. F.

1295. *Quantitative Relation between the Range of α-Particles and the Number of Charges emitted during Disintegration.* **A. van den Broek.** (Phil Mag. 25. pp. 740–742, May, 1913.)—Rutherford observed that there appears to be a relation between the period of transformation of a product and the velocity of the α-rays expelled from it. Geiger and Nuttall [see Abstract No. 163 (1912)] showed that in the great majority of cases the range of the α-particle increased with the decrease of the period of transformation. Plotting the logarithm of the range of the α-particle against the log. of the constant of transformation, the products of the uranium and radium series lie nearly on a straight line. In the Th and Ac series again most of the products lie approximately on a straight line parallel with the line showing the relation for the Ur Ra series. It is now suggested that the following relations seem to exist, first between the initial velocity of the α-rays and the number of charges expelled during disintegration: $\log V_\alpha = A + nB$; and second, between the period of transformation and the number of charges expelled $\log \lambda = C + nD$; where B and D are general constants, A and C special constants for each series, and n is the number of charges expelled. A curve is given in which $\log V_\alpha$ is plotted against n. A. E. G.

1296. *The Laws of Deflection of α-Particles through Large Angles.* **H. Geiger** and **E. Marsden.** (Phil. Mag. 25. pp. 604–623, April, 1913.)—In a former paper [see also Abstract No. 698 (1912)] it has been shown that in the passage of α-particles through matter the deflections are, on the average, small, and of the order of a few degrees only. It was also shown that the results could be explained on the assumption that the deflection of a single

α-particle is the resultant of a large number of very small deflections caused by the passage of the α-particle through the successive individual atoms of the scattering substance. α-Particles are, however, sometimes turned through very large angles. This is made evident by the fact that when α-particles fall on a metal plate, a small fraction of them, about 1/8000 in the case of Pt, appear to be diffusely reflected. This amount of reflection, although small, is too large to be explained on the simple theory of scattering. The main difficulty of the present experiments has arisen from the necessity of using a very intense and narrow source of α-particles, owing to the smallness of the scattering effect. All the measurements have been carried out by observing the scintillations due to the scattered α-particles on a zinc-sulphide screen. The object is to test a theory of the atom proposed by Rutherford, the main feature of which is that there exists at the centre of the atom an intense, highly concentrated, electrical charge. The verification is based on the laws of scattering which were deduced from this theory. The following relations are verified experimentally. The number of α-particles emerging from a scattering foil at an angle ϕ with the original beam varies as $1/\sin^4(\phi/2)$, when the α-particles are counted on a definite area at a constant distance from the foil. This relation is tested for angles varying from 5° to 150°, and over this range the number of α-particles varies from 1 to 250,000 in good agreement with the theory. The number of α-particles scattered in a definite direction is directly proportional to the thickness of the scattering foil for small thicknesses. For larger thicknesses the decrease in velocity of the α-particles in the foil causes a somewhat more rapid increase in the amount of scattering. The scattering per atom of foils of different materials varies approximately as the square of the atomic weight. This relation is tested for foils of atomic weight from that of carbon to that of gold. The amount of scattering by a given foil is approximately proportional to the inverse fourth power of the velocity of the incident α-particles. This relation is tested over a range of velocities such that the number of scattered particles varies as 1 : 10. Quantitative experiments show that the fraction of α-particles of RaC which is scattered through an angle of 45° by a gold-foil of 1 mm. air equivalent ($2{\cdot}1 \times 10^{-5}$ cm.) is $3{\cdot}7 \times 10^{-7}$ when the scattered particles are counted on a screen 1 sq. mm. area placed at a distance of 1 cm. from the scattering foil. From this figure and the foregoing results it can be calculated that the number of elementary charges composing the centre of the atom is equal to half the atomic weight. A. E. G.

1297. *Penetrating γ-Radiation.* **A. B. Chauveau.** (Le Radium, 10. pp. 69–75, Feb., 1913.)—The author concludes that the number of ions produced per c.cm. per sec. in the air in a closed vessel, due to the penetrating γ-rays, are distributed as follows :—(1) Number due to radio-active products in suspension in the atmosphere, 0·1 to 0·2 ; (2) number due to active deposits carried to the surface of the earth by the ordinary atmospheric fall of potential or by rain, 1 to 2 ; (3) number due to the radiation from radio-active matter present in the soil, 4 to 5. The variations in the amount of penetrating radiation at the same place are presumed to be due to variations in the amount of (2). E. M.

1298. *Long-period Actinium Products.* **O. Hahn** and **M. Rothenbach.** (Phys. Zeitschr. 14. pp. 409–410, May 1, 1913.)—A process for preparing pure AcX is described. Its half-period is 11·6 days, and not 10·2 days as previously assumed. Pure Radio-Ac and pure Ac were also prepared. The half-period

of 19·5 days for the former was corroborated. Pure Ac has no activity of its own, or if it has it is only a fraction of 1 per cent. of that of its disintegration products. It may possibly emit very slow β-rays. E. E. F.

1299. *Age of Pleochroic Haloes.* **J. Joly** and **E. Rutherford.** (Phil. Mag. 25. pp. 644–657, April, 1913.)—It is now well established that the minute circular marks seen in sections of certain coloured rock minerals—notably the coloured micas—are due to the effects produced by the α-radiation of a central radio-active particle. The circular mark represents the section or projection of a sphere defined by the range in the particular containing mineral, of the most penetrating α-ray emitted. Haloes are found in which the effects of other and less penetrating α-rays of the Ur and Th families may be clearly shown. Thus in the case of the Ur derivatives, the halo may be limited by the range of RaA, by Ra emanation, by Ra, or even by Io or Ur. The halo is in every case the result of the integral actions of rays emitted since a very remote period. Haloes in the younger rocks are unknown. It is of interest to seek to estimate the time required to generate these haloes. This can be done if the following data are available :—(*a*) The number of α-rays which will produce a certain intensity of staining in a particular mineral. (*b*) The mass of a nucleus of a halo of similar or comparable intensity of staining in this same mineral, and from this an estimate of the quantity of radio-active substances which may be concerned in generating the halo. It is evident that while the numerical values involved in (*a*) can be obtained with a considerable degree of accuracy, certain assumptions enter into those required in (*b*) which render them uncertain within particular limits. Thus, while the dimensions of the nucleus may be determined with fair accuracy and its mineral nature inferred with considerable confidence there are no means, at present, of ascertaining the amount of radio-active material it contains. The present experiments and observations are confined to the brown mica, Haughtonite of Co. Carlow. In this mica haloes due to the Ur family of elements are well defined and found in every stage of development. Some of the haloes may have been formed somewhat subsequent to the crystallisation of the containing mica. From results given it would seem safe to assume 10 % of Ur as an upper limit to the amount now contained in the nuclei of the haloes in this mica. The highest of the measurements obtained point to an age not less than four hundred millions of years as the time required to generate these haloes ; in other words, as the age of the early Devonian. This is somewhat excessive compared with results of previous estimates. The treatment of the subject throughout the paper has been such as to render this a minor limit. Experiments are described which have for their aim the ascertaining the number of α-rays required to produce notable staining in Carlow mica. The following sources of error are also inquired into : (*a*) The nuclei are not complete nuclei. (*b*) The crystallographic direction in which a part of the ray traverses the mica in the case of the halo is not the same as that in which the rays move in the mica when generating the experimental darkening. (*c*) Nothing is known of any mode by which the mere passage of time can intensify a halo or increase the effects of original ionisation. (*d*) The rate of formation of the experimental staining is very fast compared with the rate of formation of the halo. (*e*) Exposure to light does not appear to affect one way or the other the staining produced in this mica by the α-ray. (*f*) Thorium is absent from these nuclei.

No Th haloes have been found in this mica. A. E. G.

HEAT.

1300. *Thermal Conductivity of Crystals.* **N. Botez** and **H. Hertenstein.** (Phys. Zeitschr. 14. pp. 332–336. April 15, 1913.)—Gives some results of measurements by Voigt's method of twin plates (1897). A rectangular plate is cut out of a crystal in a plane parallel to two principal arcs of conductivity. The axes of co-ordinates are put parallel to the edges of the plate. Then the plate is halved by cutting along the X-axis and the two halves are made into a plate of the original size after turning one of the halves through 180°. Then, if there is any difference in the thermal conductivities along the two axes, the isothermals will show a break at the junction of the plates when the common edge is heated. Among the crystals thus observed were aragonite, topaz, baryta, vesuvian, rutile, calc-spar, dolomite, quartz, beryl, and apatite. The greatest angle between the isothermals was observed in quartz (50°), in which the ratio of conductivities is 0·57. Rutile was the next (2°). The method is superior to that of isothermal ellipses. E. E. F.

1301. *Thermal Properties and Viscosity of Gases.* **A. Eucken.** (Phys. Zeitschr. 14. pp. 324–332. April 15. 1913.)—Examines the relation $k = Kc_v\eta$ between the thermal conductivity K, the specific heat c_v and the viscosity η [see Abstracts Nos. 180, 517 (1912)]. Gives the thermal conductivities of pure He, H, CO, NO, N_2O, NH_3, CH_4, C_2H_4, and C_2H_2 at 21°, and of these and other gases at 273°. Assuming a complete exchange of energy of molecules on collision the factor K is 2·5 for the energy of translation, 1 for the energy of rotation, and between 1 and 1·5 for the energy of oscillation. The total energy assumes a corresponding mean value. In the case of hydrogen the value of K becomes nearly 2·5 at very low temperatures, which value applies to monatomic gases. In some gases the transfer of energy is imperfect, and K falls below the calculated value. In helium the translational energy is imperfectly transferred, in CS_2, NH_3, and CO the rotational energy. Avogadro's number, calculated from N_2, O_2, Ar, and CO_2 on Chapman's theory, gives a mean value 63×10^{22}. E. E. F.

1302. *Latent Heats of Chloroform and Benzene and of their Mixtures between 0° and 80°.* **J. Fletcher** and **D. Tyrer.** (Chem. Soc., Journ. 103. pp. 517–528, April, 1913.)—The principle of the method used for measuring latent heats is as follows:—A known weight of the liquid is placed in a vessel immersed in a thermostat; the pressure on the vessel is maintained equal to or slightly less than the saturation vapour-pressure of the liquid, which will consequently evaporate and in so doing absorb heat from the thermostat. This absorbed heat is the latent heat measured. Instead of measuring the temperature change with a thermometer, it was determined indirectly by heating electrically the calorimeter by just so much as it was cooled in the vaporisation of the liquid, and measuring the current used in heating by means of a silver voltameter. The latent heats of pure chloroform and pure benzene, and mixtures of these liquids of varying compositions were thus determined between the ordinary temperature and the boiling-points. For any given mixture the latent heat is found to be a linear function of the temperature, and for a given temperature the latent heat is approximately a linear function of the composition. T. S. P.

1303. *Latent Heat of Evaporation of Aqueous Salt Solutions.* **R. G. Lunnon.** (Phys. Soc., Proc. 25. pp. 180–191, April, 1913.)—The author has measured the heat absorbed in the vaporisation of steam for several saturated aqueous solutions of salts as well as for some unsaturated solutions of varying concentration. A jacket calorimeter method was used, a measured quantity of heat being supplied to the boiling solution by means of a small electric lamp, and the steam weighed. From the latent heats so obtained the heats of solution of the various salts are got by deducting the corresponding latent heat values for pure water. The salts investigated were sodium and potassium nitrates, sodium and potassium chlorides, and potassium chromate and dichromate. L. H. W.

1304. *Thermodynamic Properties of Twelve Liquids between* 20° *and* 80° *and up to* 12,000 *kg. cm.*^{2}. **P. W. Bridgman.** (Amer. Acad., Proc. 49. pp. 4–114, May, 1913.)—The author determines, by methods essentially similar to those used in his previous work, volumes, thermal dilatation, isothermal compressibility, work of compression, heat of compression, change of internal energy, and specific heats at constant pressure and volume for the following substances :—Methyl, ethyl, propyl, isobutyl and amyl alcohol, ether, acetone, carbon disulphide, phosphorus trichloride, ethyl chloride, bromide and iodide. The results are presented in numerous diagrams and their thermodynamic significance is discussed. The experiments disclose an unexpectedly complicated state of affairs at high pressures, in many cases the complete reverse of what might be expected from low-pressure observations. Thermal expansion may decrease with increasing temperature apparently for all liquids above 3000 kg./cm.^{2} ; this is shown to have a bearing on previous theories. The internal energy passes through a minimum value and increases with increasing pressure. This is because beyond a certain pressure the attractive forces do less work than is done by the external forces in compressing the molecule. In forming a theory of liquids at high pressures the shape of the molecule seems worthy of consideration because of the proximity of the molecules at high pressures. The author shows in detail the plausibility of such speculations. It would appear from the author's work that at high pressures, pressure is caused by something additional to the kinetic reactions of the standard theory. H. S. R.

1305. *Temperature of a Wedge-shaped Cavity and its Use as a Black Body.* **B. J. Spence.** (Astrophys. Journ. 37. pp. 194–197, April, 1913.)—Mendenhall has previously described the properties of the radiation emitted by the interior of a wedge-shaped cavity at various temperatures [Abstract No. 770 (1911)]. If the temperature of the wedge could be determined by means of a thermo-couple inserted somewhere within the wedge, its usefulness would be much increased ; *e.g.* it could be used as a black body for the calibration of optical pyrometers. Again, we may determine the relation between the true temperature of a substance and its corresponding black-body temperature, using a pyrometer to determine the black-body temperature ; the thermo-couple would give the true temperature. To measure the temperature of the wedge a thermo-couple with very fine wires was introduced into a piece of very fine-bored and thin-walled silica tubing of the same length as the Pt-foil used for the wedge. The foil (3·5 × 2 cm.) was folded, and, at the folded part, wrapped completely round the silica tube, the projecting part of the foil forming the wedge. Experiments on the melting-point of gold showed that the couple gave accurately to at least 1 in 1000, the temperature of the

wedge, also that the radiation from the interior of the wedge approximated more closely to that of a black body at the melting-point of gold than did the black-body furnace. Experiments on the difference between the true wedge temperature as determined by the thermo-couple and the corresponding black-body temperature indicated by the radiation from the exterior of the wedge were carried out for temperatures between 985° C. and 1530° C. The results are tabulated and agree with those of Waidner and Burgess and also those of Mendenhall. A. W.

1306. *Principle of Least Work of Deformation.* **T. Pöschl.** (Phys. Zeitschr. 14. pp. 410–412, May 1, 1913.)—Referring to H. Lorenz's deduction of the principle of least work by Ritz's method [Abstract No. 540 (1913)], the author gives a more direct proof that the internal work is a homogeneous quadratic function of the displacements, and the external work a homogeneous linear function. E. E. F.

1307. *The Constant in the Radiation Law.* **J. de Boissoudy.** (Comptes Rendus, 156. pp. 1364–1366, May 5, 1913.)—A preceding note by the author contains the substitution of a minimum energy term in Planck's classical hypothesis, to render applicable the principle of equipartition. The formulæ of Wien and Lorentz for the energy of black radiation are then discussed. On the above assumption the law of Stefan-Boltzmann, viz. $W = uT^4$ is obtained, where u is the constant and T the temperature. The experimental data of Féry and Drecq are next discussed, and the value of the constant u is given; its value is higher than those on the Planck and Kurlbaum formulæ. H. H. Ho.

1308. *Radiation Measurements.* II. **W. Gerlach.** (Ann. d. Physik, 41. 1. pp. 99–114, May 22, 1913.)—Discusses the various determinations of the radiation constant and defends the author's value of Feb., 1912, with the addition ± 1 per cent. The following five recent values are given for this constant σ:—

Shakespeare (Nov., 1911)	$5{\cdot}67 \times 10^{-12}$
Gerlach (Feb., 1912)	$5{\cdot}90$,,
Puccianti (May, 1912)	$5{\cdot}96$,,
Westphal (Oct., 1912)	$5{\cdot}54$,,
Keene (Dec., 1912)	$5{\cdot}89$,,

[See Abstracts Nos. 1230 (1912), 99 and 1176 (1913).] E. H. B.

1309. *Theory of the Accumulation of Energy with Intermittent Illumination, and Basis of the Law of Dark Radiation.* **E. Marx.** (Ann. d. Physik, 41. 1. pp. 161–190, May 22, 1913.)—Experiments by the author, in conjunction with K. Lichtenecker, on the accumulation of light-energy when employing intermittent illumination, lead to the conclusion that the amount of electronic emission from Elster and Geitel's potassium cells is completely independent of the division of the illuminating energy. Numerical details of the experiments are given. The result that an electro-optical effect is obtained by a light intensity of 6×10^{-8} erg/sec. cm.^{2} is worthy of note with respect to the theory of the mechanism of emission and absorption, being directly concerned with the fundamentals of the law of dark radiation. Assuming that the electron which is liberated by the illumination of the potassium cells originates from a resonated oscillation, the energy necessary for liberation

must be withdrawn from the incident light. A mathematical treatment then follows for the case when the max. energy is abstracted from the light, *i.e.* when complete resonance takes place, and also for the case when the electron's oscillations are damped by the radiation. The experimental results are then compared with Lorentz's value for the limiting energy of the incident light below which no electro-optical effect can take place, assuming that the light-energy is distributed uniformly over the wave-front and throughout the volume. The comparison shows that electro-optical effects have been obtained with light of much smaller energy than the above theory demands. After considering emission theories, the author remarks that the electro-optical experiments are explicable on the old wave theory with certain assumptions, and if the damping term in the fundamental electronic equation be retained. The latter involves concentration zones, but these are compatible with the wave theory, while it is probable that the measured intensity of light is an average value from waves of varying amplitude. Lorentz has therefore proposed that the max. intensities possible when an average is assumed may account for the electro-optical phenomena. The author then gives a mathematical discussion of the problem from the standpoint of concentration zones. The fundamental principles involved in the accumulation of energy by exposure to Röntgen rays are next considered, and the same difficulties encountered as in the case of electro-optical effects. The different hypotheses as to the nature of the concentration zones are then critically examined. The cause of no gaseous ionisation taking place when ordinary light traverses gases, as well as the ionisation effects produced by ultra-violet light, are investigated, and the conclusion drawn that in the assumption of concentration zones, whose volumes depend on the wave-lengths, lies the possibility of explaining gaseous ionisation by different light rays. The following are the final conclusions :—(1) The negative results of experiments to establish an accumulation with very feeble light-energy, using intermittent illumination of duration 10^{-7} sec., and the appearance of an electro-optical effect at 10^{-8} erg/cm.^{2} sec., are, on the assumption of an isotropic light distribution, not in agreement with the fundamental electronic equation on the one hand and with Planck's radiation law on the other. (2) The assumption of concentration zones in the transversely vibrating light rays, of volume equal to the active volume of the vibrating electron, can be defended on the fundamental equation without contradicting the electro-optical phenomena. It was found that the energy portion of the zones was only 0·01-0·001 % of the average light-energy. This renders possible the explanation of concentration zones as abnormal amplitudes on the old wave theory. On the other hand, the possibility arises of accepting Einstein's interpretation of the zones as light-quanta. (3) Only by entire omission of the damping term can harmony be preserved with the experimental results when isotropic light-distribution is retained. Planck has thereby founded his explanation of dark radiation, but the difficulties are so considerable that this explanation appears to possess no special advantage over the other. (4) The production of kathode rays by γ- or Röntgen-rays appears incapable of explanation without the assumption of concentration zones, even if the wave surfaces are of sharp conical form. (5) The failure of ordinary light to produce gaseous ionisation is inexplicable when the damping term is omitted. (6) J. J. Thomson's interpretation of the concentration zones as necessitated by the æther thrust due to the sudden emission of an energy element renders possible an experimental criterion for the existence of concentration zones. H. H. Ho.

SOUND.

1310. *Relative Sound Intensities and the Rayleigh Disc.* **G. W. Stewart** and **H. Stiles.** (Phys. Rev. 1. Ser. 2. pp. 309–315, April, 1913.)—The absolute intensity of sound has been measured principally in four ways, viz. :—(1) by the Rayleigh disc [Zernov, Abstract No. 1128 (1908)] ; (2) by the increased pressure at a reflecting wall [Altberg, Abstract No. 1471 (1904) and Zernov, Abstract No. 2054 (1906)] ; (3) by measuring pressure-changes at nodes of stationary waves by a manometer (Raps, Ann. d. Physik, 36. p. 273, 1889) ; and (4) by optical interference methods (Raps, Ann. d. Physik, 50. p. 193, 1893, and Sharpe, Science, 9. 1910, 1909, p. 808).

In some of the experiments just referred to, varying measurable sound intensities were produced, but in such a manner as to be unavailable for the calibration of intensity-measuring devices of various kinds. Indeed, the authors found no record of a successful effort to produce known varying intensities available for testing purposes. The inverse square law is quite inaccurate even out of doors.

The theory of the acoustic shadow [see Abstract No. 885 (1912)] produced at any distance from a rigid sphere with the source located on the sphere suggested a method of producing known variations of intensity, and thus obtaining a calibration device for sound-measuring apparatus. This plan was adopted, the sphere being of cement 5 cm. thick and 135·9 cm. circumference. The sound was from an electric fork, of 256 per sec., and issued from an opening in the sphere about 5 cm. diam. The detector was a Rayleigh disc, having a mirror 0·6 cm. in. diam. of very thin microscope cover glass suspended by a quartz fibre, its period being 6 secs. The results show that this method of producing relative sound intensities is a practicable one, and that the theory of the sound shadow is correct if it be assumed that the deflection of the Rayleigh disc is proportional to the energy. E. H. B.

1311. *Sensibility to Pitch.* II. **H. Muraoka.** (Kyōtō Coll. Sci. Engin., Mem. 5. pp. 19–31, Oct., 1912.)—In the first part of this research dealing with the range from $n = 128$ to 1280 per sec., the following conclusions were drawn : If dn denote the increment of frequency which is perceptible, then with a purely psychophysical test $dn/n = 0{\cdot}0029$; with a second or interchanging test, $dn/n = 0{\cdot}0020$; while with a mechanical test $dn/n = 0{\cdot}0011$. The present, or second, part of the research was undertaken to extend the examination to higher and lower regions of pitch. On account of many difficulties this has, however, not been quite accomplished. The author finds that it is scarcely possible at present to speak of an exact value of dn/n, so much depends on the manner of making the test. Values of 0·0031 and 0·00095 are here obtained by various methods. [See Abstract No. 105 (1911).] E. H. B.

1312. *Artificial Hiss.* **E. R. Marle.** (Nature, 91. pp. 371–372, June 12, 1913.)—In reply to a previous query as to the artificial production of a hiss, it is here suggested that a piece of sheet iron or compressed charcoal should be held in the small pointed flame of an ordinary foot blowpipe when the air supply is somewhat in excess of the needs of the flame. By adjusting the

supply of gas, the pressure of air and the position of the iron sheet, sounds can be obtained varying from *f* to *s* or *sh*. The oxyhydrogen flame with slight excess of oxygen is even better. The air entering a vacuum desiccator through a narrow stopcock gives a fairly good *s* sound.

H. L. Kiek (Ibid.) points out that a loud hissing noise accompanies the passing of an electric arc across the gap in such a lamp as is used for optical lanterns. The actual "hiss" sounds much more of a sibilant than an "f," such as is produced by a current of air forced under pressure through a small opening. **E. B. Titchener.** (Ibid. p. 451.) E. H. B.

1313. *Mechanical Maintenance of Vibrations of Bars, Forks, and Plates.* **H. Magunna.** (Comptes Rendus, 156. pp. 1373–1374, May 5, 1913.)—Describes a method of maintenance of vibration of forks, etc., by endless belts which are rosined and thus act like a violin bow. Instead of the belt a cylindrical drum or a flat disc may be used. [For photograph of apparatus and description of its application to musical-spark emission, see Rev. Élect. 19. pp. 434–435, May 2, 1913.] E. H. B.

1314. *Origin of Subjective Combination Tones.* **J. Peterson.** (Ann. d. Physik, 40. 4. pp. 815–816, April 15, 1913.)—Discusses the various views held by different physicists, and cites a previous publication of the author's to the effect that the conditions favourable to the production of combinational tones are found in the liquids of the cochlea. [See Abstract No. 911 (1911).] E. H. B.

1315. *Complex and Intermittent Sounds.* **Marage.** (Comptes Rendus, 156. pp. 155–158, Jan. 13, 1913.)—Discusses by aid of certain vibration-traces the education of deaf mutes, pointing out that simple vibrations should precede the more complex and intermittent ones that are needed in ordinary speech. E. H. B.

1316. *Theory of Edge Tones.* **W. König.** (Phys. Zeitschr. 13. pp. 1053–1054; Discussion, pp. 1054–1055, Nov. 1, 1912. Paper read before the 84. Naturforscherversamml., Münster, Sept., 1912.)—A discussion of the production of tones in cases where a blade-shaped stream of air strikes an edge or corner or pipe lips without a pipe space. If *a* is the distance from the opening through which the air issues to the edge which it strikes and the speed of the flow is *v*, it is calculated that the frequency of the tone is $v/2a$ nearly. E. H. B.

1317. *Thunder.* **W. Schmidt.** (Akad. Wiss. Wien, Ber. 121. 2a. pp. 2045–2062, Nov., 1912.)—This is a preliminary paper describing a registering apparatus which gives a pressure-time curve for thunder. The paper includes a reproduction of the wavy curve thus obtained. E. H. B.

1318. *Objective Combination Tones.* **E. Waetzmann** and **G. Mücke.** (Deutsch. Phys. Gesell., Verh. 15. 8. p. 348, April 30, 1913.)—Corrects the description of Fig. 2 in the paper to which this is a supplement [see Abstract No. 649 (1913)]. E. H. B.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

1319. *Collisions between Gas Molecules and Slow Electrons.* **J. Franck** and **G. Hertz.** (Deutsch. Phys. Gesell., Verh. 15. 9. 373–390, May 15, 1913.)—An experimental research, of which the chief results may be thus summarised :—(1) In agreement with Lenard it is found that the free paths of the electrons at speeds between 10 and 2 volts are very near those of free paths calculated from the kinetic gas theory, so that the electron affinity and electric charge appear to have no marked influence at these speeds. (2) It is shown that in collisions between electron rays of this range of speeds and molecules of helium and hydrogen the electrons are reflected with a relatively small loss of energy. (3) From these facts certain theoretical conceptions are developed. [See Abstracts Nos. 2958 (1904) and 840 (1910).]

E. H. B.

1320. *Electric Conduction by Free Electrons and Carriers.* II. **P. Lenard.** (Ann. d. Physik, 41. 1. pp. 53–98, May 22, 1913.)—The second part of the whole theoretical and mathematical treatment of this subject, with tables and many footnotes, being abstracts from a lecture before the Heidelberg Academy of Sciences. [See Abstract No. 1180 (1913).] E. H. B.

1321. *Initial Energies of Photoelectrically-liberated Electrons.* **H. J. van der Bijl.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 330–347, April 30, 1913.)—The object of this work was to show that many determinations of initial energies were lacking in various essential respects. In particular the following effects have been here investigated : (1) The hindrance to electron reflection due to the auxiliary field ; (2) the contact potential between the plates ; (3) the glow discharge. The auxiliary field may affect the initial energies by 40 volts or more. E. H. B.

1322. *Electron Theory of Metals.* **K. F. Herzfeld.** (Ann. d. Physik, 41. 1. pp. 27–52, May 22, 1913.)—Mathematical treatment. E. H. B.

1323. *The Large Ions in the Atmosphere.* **H. Kennedy.** (Royal Irish Acad., Proc. 32. pp. 1–6, June, 1913.)—In a previous paper some measurements were recorded of the number of ions found in the atmosphere in the city of Dublin. [See Abstract No. 213 (1913).] As it seemed probable that this number was largely influenced by the town site the further experiments described in the present paper were made on a site close to the sea-shore at Dalkey, 8 miles to the south-east of Dublin. The mean number of large ions present was found to be less than 1000 per c.cm. as compared with 16,000 found in Dublin. The only occasion on which a large number of ions was found was on a day when the wind was blowing directly from Dublin. The author therefore concludes that by far the greater part of the large ions existing in the atmosphere of the city are due to local combustion products. He considers it probable that large ions are formed for the most part by the combination of a small ion with one of the minute drops formed in the cooling gases

rising from sources of combustion, and that they are identical with Aitken's "condensation nuclei." The number of small ions found in the present experiments was 700 per c.cm. This is a much larger number than that found in Dublin, and is in good agreement with the results obtained in general by observers using the Ebert apparatus. It is considered probable that the small number found in the city was due to the combination of the greater part of the small ions with the gaseous products to form large ions.

J. S. Di.

DISCHARGE AND OSCILLATIONS.

1324. *Influence of the Valency of the Metal upon the Photoelectric Effect of Metallic Compounds.* **G. A. Dima.** (Comptes Rendus, 156. pp. 1366–1368, May 5, 1913.)—Hallwachs' phenomenon is first cited, viz., that almost all negatively charged bodies emit negative charges when exposed to ultra-violet light. The author has made a series of preliminary experiments in air at ordinary pressures, to ascertain whether a metal of different valency in an analogous compound influences the emission of electric charges. The apparatus employed was a condenser one of whose coatings was charged to a constant positive potential of about 100 volts, while the other was connected to the substance to be examined. The latter combination was connected either to earth or to a quadrant electrometer, while readings were taken over a given interval. A quartz mercury lamp was the source for the ultra-violet light, variations of the lamp with time being taken into account. The substances examined were chemically pure, and as powder were contained in silver capsules so that conditions were the same for all. Compression of the powder was found to have great influence upon the emission, this growing more or less rapidly with compression, but tending towards a limit. A table is given for a large number of stable substances, and in every case the compound in which the metal has the smallest valency appears to have the greatest photoelectric power. On the electronic theory this is explained by the fact that where the metal is monovalent it has a greater positive charge, thereby producing the most feeble emission of negative corpuscles.

H. H. Ho.

1325. *Reflection Coefficient of Metallic Films. Longitudinal Action and Penetration in Photo-electricity.* **A. Partzsch** and **W. Hallwachs.** (Ann. d. Physik, 41. 2. pp. 247–272, June 3, 1913.)—An experimental research of which the chief results are as follows :—(1) A series of kathode-deposited Pt-films of 1 to 50 $\mu\mu$ thickness were examined for the passage of light both forwards and backwards, the incident, reflected and transmitted beams being all measured. By illumination from behind 40 per cent. more light remained in the film than by illumination from the front. The reflection coefficient from quartz to platinum at first decreases with increasing thickness of film from zero ; at about 3 $\mu\mu$ a minimum occurs ; at about 7 $\mu\mu$ the original value recurring. This result is in accord with theory. (2) A longitudinal action, if usually present, is of a smaller order of magnitude than has hitherto been supposed. [See Abstracts Nos. 550 and 1408 (1912), and 669 (1913).]

E. H. B.

1326. *Elster and Geitel Potassium-Hydride Cell.* **E. Marx** and **K. Lichtenecker.** (Ann. d. Physik, 41. 1. pp. 124–160, May 22, 1913.)—Describes an experimental investigation of the influence of subdivision of

the time of illumination on the emission of electrons in an Elster and Geitel potassium-hydride cell for very small incident light-energy. The conclusion is reached that within the limits of error (1 or 2 %) a variation of the illumination time in the ratio $4{\cdot}38 \times 10^{-8}$ sec. to $1{\cdot}46 \times 10^{-7}$ sec., or 1 : 30,000, with the same incident energy of light per sec. of 0 5 erg/sec./cm.^{2} produced no effect on the quantity of the electrons emitted. [See Abstracts Nos. 1087 (1911) and next Abstract.] A. W.

1327. *Sensibility of Photoelectric Cells.* **J. G. Kemp.** (Phys. Rev. 1. Ser. 2. pp. 274–293, April, 1913.)—Gives a systematic quantitative study of the conditions of sensibility of photoelectric cells of alkali metals with hydrogen, and a determination of the work required to draw an electron out of an atom. The following facts are established for the type of cell employed : (1) Owing to the low melting-point of Cs the use of this metal in photoelectric cells for photometric use is very impractical. (2) The temperature at which it is best to operate a potassium cell is about 25° C. (3) Cooling the potassium cell much below 25° C. does not increase its sensitiveness. (4) The sensibility of a potassium cell can be increased more than 100 times by the process of forming the hydride surface. (5) The distance between the electrodes for best sensitiveness is about 0·5 cm. (6) The hydrogen gas pressure at which the cell is most sensitive lies between 2 and 3 mm. of Hg. (7) The p.d. applied to the electrodes for most sensitive conditions is about 330 volts. (8) The minimum energy required to produce an ion by collision was calculated from the data and found to be of the order $1{\cdot}77 \times 10^{-11}$ erg, while the theoretical value determined is $1{\cdot}63 \times 10^{-11}$ erg. (9) Assuming that the straight lines obtained which show the relation between current and intensity of illumination hold for exceedingly small intensities, then by using a tilted electroscope of sensibility 10^{-15} amp. a candle could be detected at a distance of 2·7 miles. This indicates that it is highly probable that a photoelectric cell could be used in astrophotometric work. [See Abstracts Nos. 1579 (1909), 958 (1910), and 1381 (1911).] A. W.

1328. *Pressure of Kathode Rays.* **E. v. Angerer.** (Ann. d. Physik, 41. 1. pp. 1–26, May 22, 1913.)—The work of earlier experimenters, such as Crookes, Puluj, Riecke, and Starke, is first referred to. In the present experiments an attempt is made to repeat the researches of Starke, but the work is not complete. The apparatus employed and method of carrying out the experiments are described. From the results it is concluded that it is possible to measure, to some per cent., the pressure of the kathode rays, but it does not appear probable that measurements can be made of sufficient accuracy to determine from the same data the value of e/m, or to make a decision between the relative and absolute theory. As a side issue it is found that it is possible to maintain a vacuum of 8×10^{-7} mm. Hg by means of charcoal in a Dewar flask containing liquid air, and to measure the vacuum by a Knudsen manometer. With a Wehnelt kathode in action a vacuum of 4×10^{-5} mm. Hg can be maintained. A. E. G.

1329. *Occurrence of Neon in Vacuum Tubes containing Hydrogen.* **I. Masson.** (Chem. Soc., Proc. 29. p. 233, June 28, 1913.)—Experiments to test the results of Collie and Patterson [Abstract No. 1036 (1913)] have yielded independent evidence of the fact that neon appears after the passage of an electrical discharge through a vessel containing a gas previously free from neon. When pure dry hydrogen is sparked in a discharge tube bearing

a perforated aluminium disc kathode and having a vacuous jacket surrounding it, after a time neon ceases to be formed. On then admitting a mixture of oxygen and hydrogen and passing the discharge, the tube appears to be rendered "active" once more, for thereafter neon is steadily produced when hydrogen is sparked. In all these experiments hydrogen accumulated in the initially vacuous jacket and had apparently passed through from the discharge tube. Quantities up to about $\frac{1}{3}$ c.cm are so obtained. This gas is found to contain no other, except CO in small and varying amounts. A. E. G.

1330. *Presence of Neon in Hydrogen after the Passage of the Electric Discharge through the latter at Low Pressures.* II. **J. N. Collie** and **H. S. Patterson.** (Chem. Soc., Proc. 29. pp. 217–221, June 28, 1913.)—Since the previous communication [Abstract No. 1036 (1913)] it has been proved that electrodes are not necessary for the production of helium and neon by the electric discharge through hydrogen, for if a powerful oscillating discharge be passed through a coil of wire wound round a glass bulb containing a little hydrogen, He and Ne can be detected in the residual hydrogen. It is necessary to free the gas as far as possible from Hg vapour. An apparatus is also made wherein the tube through which the discharge takes place is surrounded by a vacuous outer tube. The wires connected to the electrodes in the inner tube pass through the outer tube in glass tubes, so that there could be no discharge from any electrodes in the outer vessel. Various experiments have also been made with electrodes other than Al; the results obtained with copper being particularly interesting, since the hydrogen seems to disappear more rapidly than with aluminium electrodes, the splashed copper being in parts of a black colour. Briefly stated the results are as follows:—Electrodes are apparently not necessary for the production of He and Ne. Hydrogen in considerable quantities can be made apparently to disappear entirely in tubes through which a heavy discharge passes. A gas that gives a carbon spectrum is produced in the tubes. It entirely disappears when sparked in contact with Hg. It is not readily condensed by charcoal cooled in liquid air, nor easily oxidised by sparking with oxygen. It is possible that this gas may be the same as that discovered by J. J. Thomson and called by him X_3. When Cu, Pt, Pd, or Mg are splashed off in an ordinary vacuum tube containing hydrogen, Collie finds something is produced that, after dissolving in aqua regia, gives a precipitate in acid solution with barium chloride. In an appended note Collie gives the following results which probably account for this precipitate. Copper electrodes are used and the solution of the splash in acids is evaporated in *silica* vessels. No precipitate is obtained. The same tube is used again, and the solution of the splash is divided in half; that evaporated in glass test tubes gives a precipitate, but no precipitate is obtained with that evaporated in silica vessels. It is also suggested that it is possible that the silver solder employed to seal the Cu electrodes to the Pt may account for the precipitate. A. E. G.

1331. *Electric Brush Discharge in Water and Salt Solutions.* **H. Smith.** (Phil. Mag. 25. pp. 461–475, April, 1913.)—The electric arc burning under liquids has been investigated by Konen [Abstract No. 633 (1903)]; the spark discharge by Wilsing, Lockyer, Hale, Konen and Finger. If the secondary of an induction coil is connected to two electrodes immersed in a liquid, one electrode being a metal plate and the other a wire, enclosed in glass, with only the extreme end exposed, a luminous *brush* is obtained at this enclosed electrode. This brush was examined by Konen in a large number of liquids

and weak solutions. The brush and also the capillary discharge, in distilled water and in a few weak solutions, are further dealt with in the present paper. The character of the discharge varies considerably with the conditions under which it is produced. The spectra observed in the brush and capillary discharge are those of: *Hydrogen.*—Series spectrum, and many-lined or secondary spectrum. *Oxygen.*—Series spectrum, and many-lined or elementary-line spectrum. *Electrode.*—Spark-lines of Pt. *Solute.*—Complete spectrum, in visible part, of the metal. *Impurities.*—D-lines, red and green doublets of sodium; blue line (λ4227) and occasionally the red and green bands of calcium. The series spectrum of hydrogen in both the capillary and brush discharge increases with increase of current density, while the secondary spectrum decreases in relative intensity to the series lines. The series lines broaden considerably with the condensed discharges, and the relative intensity of the lines falls off towards the violet. The series spectrum of oxygen appears only with the higher-current-density discharges, being brighter with higher current density. The elementary-line spectrum appears in the brush with the feebler discharges only, its brightness also depending on the nature of the solution. It appears in the spectrum of the capillary, in the capillary discharge, only very faintly if at all, but in the discharge in dilute sulphuric acid it is the most important part of the spectrum of the bubble which forms at each end of the capillary. The lines of the metal of the dissolved salt appear in the brush. In the case of lithium their relative intensity varies with the salt used and also with the current. In weak solutions the metal lines are destroyed by the heavier condensed discharges. The metal lines appear very feebly in a capillary, and they are produced strongly only in the immediate neighbourhood of a metal electrode. The spark-lines of Pt appear with the condensed discharges when a spark-gap is used. A. W.

1332. *The Theory of the Glow Discharge from Wires.* **J. S. Townsend.** (Electrician, 71. pp. 348–350, June 6, 1913.)—Making the hypothesis that the conductivity of a gas is produced by the ions generated by the collisions of positive and negative ions with the molecules of the gas, the author investigates the potential gradient required to produce a discharge from the surface of a wire. If p be the pressure of the air between two concentric cylinders of radii a and A respectively and p/k be the pressure between two larger cylinders whose radii are ka and kA, it is proved that the charge Q per unit length when a discharge takes place is the same in the two cases; in other words, the charge Q is a function of pa. It is shown that Watson's experiments at different pressures verify this theorem. Assuming that all the ions are generated within the corona, the radius of which is C, and that the electric strength of air at normal temperature and pressure is 30 kilovolts per cm. we get $2Q/c = 30 = V/[c \log (b/a)] = R_1 a/c$, where b is the radius of the outer cylinder and R_1 is the potential gradient at the surface of the inner cylinder. Hence $R_1 a = 30c$ and $c - a = a(R_1/30 - 1)$. The mean value of R is approximately $(R_1 + 30)/2$, and this force ought to produce a force sufficient to cause a discharge between parallel plates at a distance $c - a$. Now from Baille's *experimental* results for parallel plates $V = 30x + 1{\cdot}35$, where x is the distance between them. Hence $V/x = 30 + 1{\cdot}35/x$, and thus—

$$(R_1 + 30)/2 = 30 + 1{\cdot}35/(c - a) = 30 + 1{\cdot}35/[R_1/30 - 1]a.$$

Finally we get $R_1 = 30 + 9/\sqrt{a}$. But since $R_1 a$ is a function of ap, we get for the critical force R_1 at the surface of a wire $R_1 = p(30 + 9/\sqrt{ap})$, where p is

in atmos., which is in practically exact agreement with Peek's formula. A theoretical investigation of the currents between a wire of fixed diam. and cylinders coaxial with it is also given, the conclusions being compared with Almy's experimental results. A. R.

1333. *Potential Disturbances due to Sounds placed in the Lighted Positive Column.* **R. Reiger.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 271–285, April 30, 1913.)—The paper deals with the subject in the following sections :— Theoretical considerations ; alteration of the potential through the introduction of glass rods into the discharge ; alteration of potential through the introduction of metal rods into the discharge ; distribution of potential in the neighbourhood of a metal rod ; dependence on the pressure of the anode- and kathode-falls at the sound ; dependence of the anode- and kathode-falls on the surface of the introduced rod ; distribution of potential in the neighbourhood of a glass rod. The most important results are as follows :—The potential is raised by the introduction of such foreign bodies as sounds. The rise in potential increases with increasing pressure and with the thickness of the sound. Thin rods of metal and glass bring about, in general, similar disturbance ; on the other hand, thick rods of metal produce much the greater disturbance. In the neighbourhood of a sound there is a marked fall of potential both on anode and kathode side, the former being much the larger. In potential measurements the diam. of the sound should be as small as possible. With double sounds, *i.e.* sounds placed a small distance apart, the disturbance of potential is very important. A. E. G.

1334. *Potential Disturbances due to Glowing Sounds in the Lighted Positive Column.* **R. Reiger.** (Deutsch. Phys. Gesell., Verh. 15. 9. pp. 355–363, May 15, 1913.)—Comparisons are made with sounds consisting of a glowing clean Pt-wire and a Pt-wire coated with CaO and the results are shown graphically, the heating currents being plotted as abscissae and the p.d.'s as ordinates. These curves clearly show the superposition of pure temperature effects and the emission of electrons. On the anode side of the sound, in addition to the temperature influence a large decrease in the potential takes place. This increases with decreasing pressure since the emission of electrons increases as the pressure is lowered. On the kathode side there is an increase of potential due to the increase of the anode-fall. The dependence of the alteration of potential on the current through the gas is considered, and it is shown that the most important result is the small nature of the alteration. In considering the potential-distribution in the neighbourhood of the glowing sound it is found that the kathode-fall vanishes on the anode side of the sound. The general conclusion is that glowing sounds with a CaO coating are of little use for practical measurements of potential on account of the considerable disturbances of potential they produce in the immediate vicinity. A. E. G.

1335. *Decrement Paper.* **L. Isakow.** (Phys. Zeitschr. 14. pp. 456–457, May 15, 1913.)—Describes and reproduces a co-ordinate paper, so divided that when all observations are plotted the whole resonance curve takes the form of two straight lines which intersect in the point of resonance. Within the limits of validity of the theory of Bjerknes all points must lie on these straight lines, and deviations may be smoothed out by a ruler. Systematic deviations prove that the decrements are not constant. E. E. F.

1336. *Absorption of Short Electric Waves by Air and Water-vapour.* **J. E. Ives.** (Phil. Mag. 25. pp. 702–710, May, 1913.)—It is well known that wireless telegraph signals can be sent farther at night than in the day. One of the suggestions that have been made to explain this fact is that the air may absorb more of the energy of the waves during the daytime than it does during the night ; the absorption of the waves being supposed to be due to the ions produced, either in the lower or in the upper layers of the atmosphere, by the action of the sunlight. It was this fact and the suggested explanation of it which led to the present research. The results of the experiments show that for electric waves about 10 cm. long passing through air at pressures ranging from 76 cm. to 0·001 cm. of mercury, and through water-vapour at pressures ranging from 1·50 cm. to 0·015 cm., the absorption of the energy of the waves by the air, if it exists, must be less than one-tenth of one per cent. per cm. This was also found to be true when the air was ionised by radium chloride placed in open vessels within the tube. This would indicate that the ionisation of the air by radium produces, if any, only a very small effect upon its absorbing power for electric waves about 10 cm. long. [See Abstract No. 655 (1908).] E. H. B.

1337. *Abnormal Dispersion of Short Electric Waves.* **F. Eckert.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 307–329, April 30, 1913. Extract from Dissertation, Berlin.)—An oscillator was used like that of Lebedew and measurements were carried out with the four wave-lengths of 88, 57, 37, and 17·5 mm. The chief results were as follows :—(1) Contrary to the work of some others, the reflection from metals agreed well with theory and in whichever plane the electric vector occurred. (2) By water the reflection coefficient, the transparency and the temperature coefficient of the absorption for the above waves were determined. (3) From these the index of refraction, the absorption coefficient, and the abnormal dispersion of water in the above region were derived. (4) For the same region the absorption per cm. in methyl-, ethyl-, propyl- and isobutylalcohol and glycerine were measured, and the abnormal dispersion of these substances confirmed. (5) For methylalcohol the index of refraction was determined, and on the basis of the value of the absorption coefficient the wave-length of the longest natural vibration obtained. [See Abstracts Nos. 1640 (1905) and 516 (1911).] *Erratum* (Ibid. p. 422, May 30, 1913). E. H. B.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

1338. *Resistance of Heated Graphite and Carbon.* **E. F. Northrup.** (Metallurgical and Chem. Engin. 11. p. 275, May, 1913.)—A rod of Acheson graphite hardly changed its resistance while being heated up to 1500° C. That carbon (*e.g.* an electric light carbon) has a negative temperature-coefficient is demonstrated by fixing a rod of carbon and a rod of graphite in holes drilled into two plates of graphite which are joined to a transformer. Though the two rods were in parallel, the graphite rod quickly became incandescent, whilst the carbon rod heated up slowly, finally to become more brilliantly incandescent than the former. H. B.

1339. *Change in Electrical Resistance due to Pressure at Low Temperature.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 947–952, April 24, 1913. Communication No. 132*b* from the Phys. Lab., Leiden.)—In this paper the result is given of a first

investigation of the change of resistance under the influence of uniform hydrostatic pressure. The measurement of the pressure coefficient, γ, at low temperatures is very difficult, for the temperature coefficient is then so great that even the smallest fluctuations of temperature can greatly affect the resistance, and thus variations of resistance may occur which completely obscure the whole phenomenon of variation with pressure. Experiments were made on a turning of lead with liquid oxygen and liquid hydrogen as compressing liquids. For the pressure coefficient Lisell gives, $\gamma = -1{\cdot}44 \times 10^{-5}$ at $T = 273°$ abs. The authors find from their measurements :

$$\gamma = -2{\cdot}25 \times 10^{-5} \text{ at } T = 90° \text{ abs.,}$$

and—

$$\gamma = -1{\cdot}7 \times 10^{-5} \text{ at } T = 20{\cdot}3° \text{ abs.,}$$

so that the pressure coefficient is somewhat greater at the lower temperatures. The increase between 273° A. and 90° A. changes again to a diminution. The accuracy of the measurements is, however, not sufficient for any significance to be attributed to this diminution. As to the decrease $-\Delta w$ in the resistance for $p = 100$ atmos. it is found to approximate to zero at the lower temperatures. Thus for lead—

273°	abs. for	$p = 100$ atmos.	$-\Delta w = 0{\cdot}017$ ohm.
90°	abs.	„ „	$-\Delta w = 0{\cdot}008$ „
20·3°	abs.	„ „	$-\Delta w = 0{\cdot}001$ „

J. J. S.

1340. *Electric Resistance of Soap Films.* **A. Hagenbach.** (Archives des Sciences, 35. pp. 329–339, April, 1913.)—Using a fresh solution of oleate of soda, concentration 1 : 40 with 1/4 of glycerine (Boys' recipe), the author finds at 23·5 to 24° the results in the following table :—

Colours.	Thicknesses by Index of Refraction.	Relative Thicknesses.	Relative Conductivities.	Conductivities / Thicknesses
Purple, 4th order	$552\mu\mu$	1	1	1
Blue sky, 2nd „	217	0·385	0·69	1·79
Violet, 2nd „	197	0·349	0·595	1·71
Brown, 1st „	119	0·210	0·543	2·58
Yellow, 1st „	102	0·180	0·487	2·71
White, 1st „	89·9	0·159	0·408	2·57
Black	12 (Reinold & Rücker)	0·0212	0·128	6·03

Experiments with Boys' rainbow cup are also described. E. H. B.

1341. *Thermoelectric Power of Silicon.* **F. Fischer, R. Lepsius,** and **E. Baerwind.** (Phys. Zeitschr. 14. pp. 439–446, May 15, 1913.)—A large number of specimens of silicon were examined as to their thermoelectric powers. It was found that Si specimens may be highly positive towards copper, and also highly negative. An apparatus was designed for the rapid examination of irregular pieces, and several methods were worked out for converting "positive" into "negative" sorts, and the reverse. The negative character appears to be due to the addition of SiO_2. On withdrawing the dissolved silica, the positive character reappears. By combining —Si and + Si, thermo-elements giving as much as 1000 microvolts per degree can be constructed. E. E. F.

1342. *Standard Cells.* **L. W. Öholm.** (Act. Soc. Sci. Fennicæ, 41. No. 1. pp. 1–113, Helsingfors, 1912.)—Gives the results of numerous experiments on standard cells having cadmium amalgam for the negative electrode, mercury for the positive electrode, and chlorides, bromides, iodides, and sulphates, of cadmium and mercury for electrolytes and depolarisers respectively. The e.m.f.'s of these cells and their temperature coefficients are given in the following table :—

Cell.	Electromotive Force.
Chloride	$E_t = 0{\cdot}67180 - 0{\cdot}000074\,(t-18^\circ) - 0{\cdot}0000015\,(t-18^\circ)^2$
Bromide	$E_t = 0{\cdot}55916 - 0{\cdot}000366\,(t-18^\circ) - 0{\cdot}0000046\,(t-18^\circ)^2$
Iodide	$E_t = 0{\cdot}41470 + 0{\cdot}000362\,(t-18^\circ) - 0{\cdot}0000003\,(t-18^\circ)^2$
Sulphate	$E_t = 1{\cdot}0186 - 0{\cdot}000038\,(t-20^\circ) - 0{\cdot}00000065\,(t-20^\circ)^2$

[It is probable that the e.m.f.'s should be reduced in the ratio 1·0183/1·0186 for the values to be in international volts.—F. E. S.] When the concentration of a solution is changed, the e.m.f. also changes. The relation between concentration and e.m.f. is shown in the following table :—

Concentration of Solution.	Electromotive Force.			
	$CdCl_2$.	$CdBr_2$.	CdI_2.	$CdSO_4$.
Saturated at 4° C.	0·6722	—	—	1·0191
3·84 normal	0·67949	—	—	—
2 ,,	0·67340	0·57052	0·41456	1·03804
1 ,,	0·70335	0·58410	0·43090	1·05016
0·5 ,,	0·71459	0·59536	0·44290	1·05778
0·25 ,,	0·72728	0·60643	0·45300	1·06509
0·10 ,,	0·74470	0·62299	0·46500	1·07526

The constancy and reproducibility of the cells were found to be very good. In the case of the sulphate cells a number, made up with dilute solutions, have fallen in e.m.f. to a marked extent, and the fall is somewhat proportional to the dilution of the solution. F. E. S.

1343. *Theory of Thomson-effect.* **H. Hörig.** (Phys. Zeitschr. 14. pp. 446–447, May 15, 1913.)—Emphasises the necessity for full experimental data bearing upon the Thomson-effect, and describes some experiments made with a silver tube 60 cm. long and 4·2 cm. external diam., heated by means of an alternating current of 600 ∼ to about 150° C. The observed e.m.f. does not exceed 10^{-5} volt per 1 deg. C. The electron theories would indicate larger values. But if Kelvin's $\int \sigma dT$ is identified with the e.m.f. of the temperature gradient (which the author does not admit), then the e.m.f. for silver would be $2{\cdot}6 \times 10^{-6}$ volt per degree. E. E. F.

1344. *E.M.F. produced by the Flow of Electrolyte Solutions through Capillary Tubes.* **L. Riéty.** (Comptes Rendus, 156. pp. 1368–1370, May 5, 1913.)—In preceding notes [see Abstract No. 1098 (1912)] the author has described a process for the measurement of the e.m.f.'s during filtration of concentrated solutions of copper and zinc salts, and has shown how to deduce from the

results obtained the potential difference of glass—electrolyte. Measurements have been made of aqueous solutions of the chloride, nitrate, sulphate, and carbonate of potassium, hydrochloric acid, and sulphuric acid, in the tube which served for the previous experiments. The non-polarisable electrodes were silver wires, coated with fused silver chloride according to Grumbach's directions. Numerical results are given, and from viscosity and conductivity measurements the p.d. between glass and electrolyte is calculated on Helmholtz's theory. For all these solutions the electrolyte possesses a greater potential than glass. From a study of potassium nitrate between wide concentration limits, the difference of contact potential appears to decrease constantly as the electrolyte concentration increases, and presents no minimum as in the case of copper and zinc sulphates. For dilute solutions the p.d. is much greater for potassium salts than those of copper or zinc. H. H. Ho.

1345. *Precision Resistances for High-frequency Alternating Currents.* **K. W. Wagner** and **A. Wertheimer.** (Elektrotechn. Zeitschr. 34. pp. 613–616, May 29, and pp. 649–652, June 5, 1913. Communication from the Kaiserl. Telegraphen-Versuchsamt.)—A consideration of the construction of resistances for use with alternating current when high precision in the measurements is required. By a suitable arrangement of the winding it is shown that the time constant of most resistances can be reduced to a negligible quantity. The means found coincide to some extent with those recently communicated by Curtis and Grover [see Abstract No. 504 (1913)]. However, in the present paper the chief results are shown graphically, and some idea is given of the uniformity to be expected when coils (intended to have negligible time constants) are produced on a manufacturing scale.

F. E. S.

1346. *The Vibration Electrometer and its Application to Alternating-current Measurement.* **H. Greinacher.** (Archiv f. Elektrotechnik, 1. No. 11. pp. 471–476, 1913.)—The author first describes the mode of working of the vibration electrometer. After remarking that a leaf electroscope or a quadrant electrometer gives a constant deflection with an alternating-current as with a direct one, the author points out that it is otherwise with the string electrometer designed specially for radio-activity or ionisation measurements. When the alternating current has not too high a frequency, the threads follow momentarily the rapid current-changes, and are therefore set in vibration. The author, from this observation, conceived the idea of using the vibration electrometer as a null instrument for alternating-current measurement. The Wulf double-thread electrometer was first employed, although later the author designed a special apparatus for the purpose. Results are described, first when the electrometer is vibrating, and second, when used as a null instrument under the ordinary Wheatstone-bridge conditions, whereby the advantage is obtained of a sensitiveness extending throughout very wide limits. The author remarks that any other statical instrument of sufficient sensitiveness could be used, *e.g.* a leaf electroscope, but points out the advantages derived from the vibration method. A special disposition is described, whereby an auxiliary battery is avoided. The vibration method may naturally be employed in such cases as the determination of electrolyte resistance, capacity measurement, &c. The author then describes an investigation in variable magnetic and electric fields. The frequency limits of the vibration electrometer are next investi-

gated and tabulated. It follows from the table that the normal vibration limit for quartz threads is fairly restricted. A new form of vibration electrometer is then described, whereby the disadvantage of the quartz thread instrument is overcome, this being the disintegration of the metallic surfaces, whereby the threads conduct badly and are finally useless. A platinum thread is utilised, and the instrument so designed as to be of very small dimensions. The same sensitiveness is attained as in Wulf's electrometer.

H. H. Ho.

1347. *New Sensitive Relay.* **H. Rohmann.** (Phys. Zeitschr. **14.** pp. 350–352, April 15, 1913.)—Describes an arrangement for utilising and enlarging small deflections, say, of a moving-coil galvanometer, without reducing the sensitiveness of the measuring system. In a coil attached to the moving system an alternating current is induced whose intensity depends upon the position of the coil, and which takes up the expenditure of work. The alternating current traverses a hot-wire instrument or works a relay. The coil is closed by means of a condenser. Its circuit is tuned to the frequency of an alternating field provided by a fixed coil. The phase difference being 90°, the electrodynamic force is zero, while the transfer of energy is a maximum. The induced current is, for small deflections, proportional to the deflection. It is conveyed by silver strips which take currents up to ½ amp. With a current in the moving coil amounting to 0·1 micro-amp., the author obtained a deflection in a hot-wire ammeter representing 0·1 watt.

E. E. F.

ALTERNATING CURRENTS AND MAGNETISM.

1348. *Magnetic Behaviour of Iron and Nickel under the Oscillatory Discharge from a Condenser.* **E. W. Marchant.** (Roy. Soc., Proc. Ser. A. 88. pp. 254–280, May 8, 1913.)—The chief object of the experiments described was the determination of the relation between magnetising force and permeability when iron or nickel is subjected to alternating magnetisation obtained from the oscillatory discharge of a condenser, especially with a view to finding the permeability with large magnetising forces. The method employed was to photograph the image of the spark produced by the condenser discharge reflected from a revolving mirror. The following are the author's conclusions :—(1) With an air condenser, the capacity of which was measured ballistically, and an air-core self-induction coil of known value, the frequency of the oscillations of the condenser discharge agrees with the values calculated by Kelvin's formula. (2) The resistance of a spark between spheres of 1 in. diam., 2·5 mm. apart, when the max. current is greater than 200 amps. does not exceed 2 ohms. With a max. current greater than 500 amps. the resistance does not exceed 0·75 ohm. (3) When an iron wire is inserted in the self-induction coil, the time for each consecutive half-oscillation increases with the duration of the discharge. (4) With a series of discharges from a given condenser in which the max. value of the magnetising current varies, the time for the first half-oscillation *decreases* with *increase* in the strength of the current. (5) The increase in the time of a half-oscillation with the duration of the discharge is due to the increase in the permeability of the iron, as the current, and consequently the magnetising force, dies away. (6) The permeability of the iron wires, calculated from the observed increase in the self-induction of the coil decreases with increase of the magnetising force. The curve connecting μ, the "effective" perme-

ability with H, the magnetising force, agrees with that obtained on the assumption that the permeability of the iron is the same as with a steady magnetising force. (7) The insertion of an iron-wire core into the coil causes more rapid damping, due to eddy-current and hysteresis losses, chiefly the former. (8) The "effective" permeability of thick wires (0·12 cm. diam.) is nearly equal to that of thin wires with the same magnetising force (between 500 and 5000 gauss). The causes of this are : (*a*) The increase in the "skin" effect with thick wire diminishes the apparent permeability ; (*b*) the increased dissipation of energy with thick wires reduces the max. value of the magnetising force, and thus increases the apparent permeability ; (*c*) the self-demagnetising force due to leakage from the surface of the wire decreases the actual magnetising force acting on the iron, thus increasing the permeability of the iron. (9) With cores of solid iron inserted into the self-induction coil, the duration of the discharge is less than with other cores ; the self-induction of the coil with solid iron cores is about 15 % greater than with air cores. (10) With nickel wire cores the effects are similar to those with iron, but of less intensity, the permeability of the nickel wire with rapidly oscillating magnetic force being similar to that with steady magnetising forces. (11) With cores of insulated copper wires no changes in damping or self-induction are apparent. J. J. S.

1349. *Demagnetisation Factors of Elliptic Cylinders.* **H. du Bois.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 305–306, April 30, 1913.)—The expression for the demagnetisation factor N of an elliptic cylinder, with semi-axes a and b and of length c, can be integrated, and gives $N_x = 4\pi b/(a+b)$, $N_y = 4\pi a/(a+b)$, and, for a long cylinder, $N_z = 0$. Taking the axis-ratio m, these expressions become $4\pi/m + 1$, $4\pi m/m + 1$, and 0, and their sum is equal to 4π [see also Abstract No. 1860 (1908)]. These extremely simple formulæ are derived in the usual manner from the general potential theory of the ellipsoid. G. E. A.

1350. *Formulæ employed in Determinations of Susceptibility.* **A. Guillet.** (Journ. de Physique, 3. Ser. 5. pp. 324–333, April, 1913.)—Starting with the Newtonian result for the force inside a homogeneous sphere of attracting material, two centres of force are taken as the basis for solution of problems in electricity and magnetism. The formulæ employed by Curie, Gouy, and Quincke in their magnetic researches are then established. G. E. A.

1351. *Hall-effect and Change in Resistance in a Magnetic Field at Low Temperatures.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 981–987, April 24, 1913. Communication No. 132*a* from the Phys. Lab., Leiden.)—The resistance of solid mercury was measured and found to be 7·97 ohms at T = 287·3° abs., 0·1014 at T = 20·3°, and 0·0618 at T = 14·5°. An increase of resistance occurs in the magnetic field. With H (in gauss) = 10,000 and T = 20·3° abs. the increase in resistance $\Delta w/w = +1{\cdot}5 \times 10^{-3}$. In the same field with T = 14·5° abs., $\Delta w/w = +6 \times 10^{-3}$. At these temperatures the temperature coefficient of resistance is very great. The large increase occasioned by lowering the temperature from 20° to 14° abs. is very striking. Observations were made with a plate of pure nickel 0·053 mm. thick. The Hall-effect for Ni decreases as the temperature falls from ordinary values as previously found by A. W. Smith [see Abstract No. 443 (1910)]. According to A. Kundt the Hall-effect for ferromagnetic substances is proportional to the magnetisation and not to the field. Hence saturation occurs for the Hall-effect, or the curves showing

Hall-effect as a function of the field should show a bend. At 290° abs. the authors' measurements show this bend at about 5000 to 6000 gauss. At the lower temperatures 90°, 20·3°, and 14·5° abs. there is no decided bend visible with $H < 10{,}400$. At 14·5° abs. the Hall-effect is strictly proportional to the field as is also the case at 20·3° abs. as far as $H = 9060$. At 90° abs. the Hall coefficient is a linear function of the field, diminishing as the field increases [Abstracts Nos. 694–698 (1913)]. For the Hall coefficient in very weak fields the relation $R_0 = ce^{\frac{b}{T}}$ holds. As previously found by other observers, there is an increase in the resistance of nickel in weaker fields ($H < 3000$); in stronger fields the resistance diminishes. A wire of pure *iron* was examined (impurity about 0·18 %). At $T = 288°$ abs. the resistance w was 11·18 ohms, at 90° abs. 2·225, and at 14·5° abs. 1·124. The temperature coefficient is very small in the liquid-hydrogen region. At 288° abs. the resistance increases in weak fields and decreases in fields greater than 7000. At liquid-hydrogen temperatures this behaviour is reversed, for the resistance diminishes in weaker fields and increases when $H > 7000$. There is a neutral zone at about $H = 7000$. J. J. S.

1352. *Hall-effect for Gold-Silver Alloys at Temperatures down to the Melting-point of Hydrogen.* **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 988–996, April 25, 1913. Communication No. 132*c* from the Physical Lab., Leiden.)—The observations on the Hall-effect in Au-Ag alloys previously described [Abstracts Nos. 697, 698 (1913)] were continued with three other alloys containing a greater percentage of silver. The values of the Hall-effect at temperatures 290°, 90°, 20·3°, and 14·5° abs. and with different magnetic fields are given. The addition of a small quantity of gold to pure silver causes a very large decrease in the conductivity. An admixture of 2 atomic per cent. of gold reduces the conductivity from $71{\cdot}10 \times 10^6$ to $1{\cdot}35 \times 10^6$; the unit being the reciprocal of the resistance in ohms of a 1-cm. edged cube. When silver is gradually added to pure gold the Hall coefficient at low temperatures diminishes at first rapidly and then more slowly until with a mixture of about equal quantities of Au and Ag a large change in the composition occasions only a very small change in the Hall-effect. The lower the temperature the steeper is the descent of the curve showing the Hall coefficient as a function of the atomic percentage of Ag. When a 2 % admixture of silver is added to pure gold the Hall coefficient diminishes

at $T = 20{\cdot}3°$ abs. from $9{\cdot}8 \times 10^{-4}$ to $6{\cdot}7 \times 10^{-4}$;
at $T = 90°$ abs. from $7{\cdot}6 \times 10^{-4}$ to $6{\cdot}6 \times 10^{-4}$;
at $T = 290°$ abs. from $7{\cdot}2 \times 10^{-4}$ to $6{\cdot}1 \times 10^{-4}$.

Hence a small Ag impurity in gold occasions only a small variation of the Hall-effect at $T = 290°$ abs., which, however, becomes more appreciable at lower temperatures. With Ag and Au the Hall coefficient increases as the temperature falls. At low temperatures alloys with more than 2 % of Ag show a distinct diminution of the Hall-effect, which is greatest for alloys of medium concentrations. J. J. S.

1353. *Hall-effect in Tellurium and Bismuth at Low Temperatures.* **H. Kamerlingh Onnes** and **B. Beckman.** (Konink. Akad. Wetensch. Amsterdam, Proc. 15. pp. 997–1003, April 24, 1913. Communication No. 132*d* from the Physical Lab., Leiden.)—The Hall-effect was measured for two plates of tellurium at temperatures down to the melting-point of hydrogen.

With the first plate the resistance increased considerably at low temperatures. At $T = 290°$ abs. the specific resistance was $1{\cdot}95 \times 10^6$ c.g.s. At 20·3° abs. the resistance was about three times as great. The resistance of the second plate attained a maximum at about 40° to 60° abs. For $Te_{\rho I}$ (the first plate) the Hall coefficient, R, was 39·1 at 290° abs., and 43·1 at 20·3° abs. For $Te_{\rho II}$ the values of R were 185·5 at 291° abs. and 214·5 at 20·3° abs. At any definite temperature R is practically constant for various fields; at lower temperatures there is an indication that R diminishes somewhat in the stronger fields. For both plates the Hall-effect increases at lower temperatures, while the ratio $R_{20°}/R_{290°}$ is the same. This is very remarkable, for the plates are completely different with regard to their specific resistance, resistance temperature coefficient, and absolute magnitude of the Hall-effect.

Experiments were continued with Bi crystals [Abstract No. 694 (1913)], and results are given for the case in which the field is parallel, and the main current perpendicular, to the axis. At ordinary temperature and in weak fields RH is negative. In stronger fields RH becomes positive. The critical negative values found by Becquerel are much greater than those of the authors, and Becquerel found zero to be attained in much stronger fields. For $H = 1000$, $R = -0{\cdot}05$ for $T = 290°$ abs.; $R = +3{\cdot}4$ for $T = 90°$ abs.; $R = +3{\cdot}11$ for $T = 20{\cdot}3°$ abs.; $R = +2{\cdot}88$ for $T = 14{\cdot}5°$ abs. J. J. S.

1354. *Production of Strong and Uniform Magnetic Fields.* **H. du Bois.** (Deutsch. Phys. Gesell., Verh. 15. 8. pp. 292–304, April 30, 1913.)—Discusses mathematically the magnetic fields obtained with pole-pieces of different forms; also deals with the question of cooling of the electromagnet. A. W.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

1355. *Metallic Beryllium (Glucinum).* **F. Fichter** and **K. Jablczynski.** (Ber. Deut. Chem. Gesell. 46. pp. 1604–1611, 1913.)—Glucinum is best obtained by the electrolysis of a fusion containing 1 mol. of sodium fluoride to 2 mols. of glucinum fluoride [compare Lebeau, Abstract No. 302 (1898)], using a nickel crucible as kathode, a carbon rod anode, and a current strength of 7–10 amps. at 15 volts. The temperature must not rise too high, otherwise an alloy of glucinum and nickel is formed. The metal is isolated from the fusion by dissolving the salts in water, the solution being prevented from becoming acid by the addition of ammonia and by repeated renewal of the water. The crystals of glucinum so obtained are freed from admixed oxide by centrifugalisation in a mixture of ethylene dibromide and alcohol (D 1·95); they have D = 1·842. The small crystals so obtained cannot be melted together under ordinary conditions, owing to the coating of oxide formed preventing coalescence ; it is necessary to form cylinders by compression, and then heat them up in an electric vacuum furnace or in one containing hydrogen at 11–15 mm. The melting-point is 1280° ± 20°. The regulus of metal has hardness between 6 and 7, and scratches glass ; the freshly filed metal is steel-grey in colour. At the ordinary temperature it is brittle, but at higher temperatures ductile. The specific resistance (referred to a wire of 1 m. length and 1 mm. cross-section) at 20° is 18·47 ohms. The resistance to the action of water is caused by a surface film of oxide. As anode in a solution of sodium ammonium phosphate it acts as a valve electrode, similarly to aluminium. It is not so readily attacked by alkalies as is usually stated to be the case. T. S. P.

1356. *Chemical Reactions and Radii of Curvature.* **G. Reboul.** (Comptes Rendus, 156. pp. 1376–1378, May 5, 1913.)—The author describes further experiments made under the conditions previously employed [see Abstract No. 729 (1913)]. A copper wire 1·5 mm. in diam. is attacked far more readily when alone than when placed near another wire, 0·15 mm. thick. The latter thus exercises a protecting action on the former. A strip of copper is similarly protected by a thin wire. The attacking gas seems to be attracted to the points where the radius of curvature is least ; the extent of the protective effect of these points increases as the pressure of the gas is diminished, and with pressures of the order 0·05 mm. amounts to several centimetres. There is thus an apparent distillation of the active substance of the gas to the points with the greatest curvatures. T. H. P.

1357. *Use of Anti-piping Thermit in Casting Steel Ingots.* **E. A. Beck.** (Amer. Inst. Mining Engin., Bull. No. 76. pp. 649–656, April, 1913.)—Some interesting details concerning the Thermit process for producing sound ingots, mentioned in Abstract No. 279 (1913), are described. The object of the method is not to heat the steel and keep it fluid, but to create a stirring action and promote the removal of gases, thus preventing the formation of blow-holes and pipes. In top pouring the can must be introduced somewhat earlier (when the crust has extended over about one-half the surface of the ingot) than in bottom pouring, because of the colder steel being at the bottom. After the cessation of the agitation the steel sinks in the mould,

and it is advisable to follow up this shrinkage. The material is improved in quality by an increase in density and by a transfer of the segregated area towards the top surface of the ingot. At the same time an increase of from 3 to 10 % in the yield is obtained. Tables are appended showing the uniformity in composition and mechanical properties of plates rolled from ingots treated by this process. F. C. A. H. L.

1358. *Commercial Production of Sound Steel Ingots.* **E. Gathmann.** (Amer. Inst. Mining Engin., Bull. No. 76. pp. 649–668, April, 1913.)—The solidification of an ingot of steel previously "killed" depends entirely upon the shape of the mould and the thickness of its walls. In the author's method of casting, the cooling of the upper part of the ingot is slow in comparison with the lower part. This is effected by making the mould walls thick and heavy for about 85 per cent. of the height of the ingot from the bottom. The upper portion of the walls are made thin and less heat-absorptive. By this means the pipe and segregate are confined to the upper 10 % of the ingot. Special stripping apparatus has been designed so that the output is probably increased under the new methods. The average discard has been reduced to 12 %, as compared with 35 to 40 % by the older methods. F. C. A. H. L.

1359. *Triferrocarbide (Cementite).* **O. Ruff** and **E. Gersten.** (Ber. Deut. Chem. Gesell. 46. pp. 394–400, Feb. 22, 1913. Chem. News, 107. p. 252, May 23, 1913. Abstract.)—According to Jermilow the molecular heat of formation of Fe_3C should be + 2·27 cals., according to the authors' determination of 1912, — 15·1 cals. But they had not themselves determined the heat of oxidation of FeO to $\frac{1}{3}Fe_3O_4$, which they now find to be + 28·6 ± 1·8 cals., in fair agreement with le Chatelier, 25·7, whose value they had previously accepted. Making this correction, the molecular heat of the formation of Fe_3C would be — 15·3 ± 0·2 cals. H. B.

1360. *Carbides of Manganese and Nickel.* **O. Ruff** and **E. Gersten.** (Ber. Deut. Chem. Gesell. 46. pp. 400–413, Feb. 22, 1913. Chem. News, 107. p. 252, May 23, 1913. Abstract.)—Mn_3C is prepared by heating in a crucible (electric vacuum furnace) for 20 minutes manganese (reduced by thermit) and carbon at 1600° C. and 20 mm. pressure. The carbide forms soft glistening needles and fibres, hardness intermediate between talc and gypsum; the hardness of alloys containing Mn_3C and Fe_3C (also soft) may be due to the solid solutions. The molecular heat of combustion of Mn_3C to Mn_3O_4 is 410·9 ± 2 cals., the molecular heat of the formation of Mn_3O_4 is 12·9 ± 2 cals. (le Chatelier 9·34 cals.). The Ni_3C is formed chiefly at 2100°, but it is unstable and decomposes again on cooling; the molecular heat of formation of Ni_3C is — 394 ± 10 cals., of Fe_3C —15·3 ± 0·2 cals.

H. B.

1361. *Rate of Rusting of Iron and Steel.* **J. Aston** and **C. F. Burgess.** (Amer. Electrochem. Soc., Trans. 22. pp. 219–240, 1912.)—Corrosion tests have been made on several commercial grades of iron and steel in the form of bars and sheets with and without scale. The tests took the form of exposure of a set of samples to atmospheric weathering, while other specimens were exposed to the exhaust of a chemical laboratory. The total period of test was 300 days, after which the depth of pitting was determined by grinding and weighing the metal removed. This weight added to the corrosion losses gives a value which has been called by the authors "equivalent corrosion,' while the ratio of this value to the actual corrosion gives the pitting factor.

Generally speaking, the results show that the acid corrosion test (exposure to 20 % sulphuric acid) gives no idea of the behaviour of the metals in practice. The corrosive action of the atmosphere is largely influenced by fumes and smoke and by the season of the year, the loss being greatest in spring. Scale does not retard rusting. Pitting is responsible for a deterioration which is three times as great as that caused by uniform rusting. Photomicrographs fail to show any marked connection between the presence of impurities and heterogeneity of structure and rate of corrosion. The authors consider that the service conditions constitute a vital factor in the corrosion of iron, and that it is just as important to study the conditions of use as to study the materials themselves. F. C. A. H. L.

1362. *Transformations of Iron-Silicon Alloys.* **G. Charpy** and **A. Cornu.** (Comptes Rendus, 156. pp. 1240–1243, April 21, 1913.)—Dilatation experiments on alloys containing 0·1 % C, 0·3 % Mn, and 0·2 to 4·5 % Si show that between these limits the addition of silicon to iron does not affect the dilatation coefficient between 0° and 700° C. The temperature of the anomaly in the dilatation curve between 800° and 900° C. is not displaced, but the magnitude decreases as the Si increases, and disappears at 1·3 % Si. Low-carbon alloys containing over 1·3 % Si show an almost rectilinear dilatation curve between 0° and 900° C. A similar result is obtained with nickel, but in this case the anomaly is not effaced but merely displaced in the scale of temperature. In a second series containing 0·35 % C and 0·8 % Mn, similar results have been obtained, but the effects are much less marked, 4·5 % Si being necessary to efface the anomaly. Comparison of the cooling- and dilatation-curves of a soft steel and a low-carbon alloy containing 3·5 % Si indicates that the point A_2 subsists after the points A_1 and A_3 have disappeared, so that it cannot be a residue of the latter transformations. F. C. A. H. L.

1363. *Transformations of Iron-Silicon Alloys.* **E. Vigoroux.** (Comptes Rendus, 156. pp. 1374–1376, May 5, 1913.)—Interest in the work of Charpy and Cornu [see preceding Abstract] has led to the publication of heating curves of pure iron-silicon alloys containing up to 7 % Si. None of the alloys showed A_1 or A_3, but addition of 0·5 % Si raised A_2 by 14° C., which increment was continued up to 3 % Si. Between 3 and 4 % Si the temperature was steady, after which it was again increased up to about 7 % Si, when the point disappeared altogether. F. C. A. H. L.

1364. *Metallographic Investigation of the System : Thallium and Tellurium.* **M. Chikashige.** (Kyōtō Coll. Sci. Engin., Mem. 5. pp. 5–12, Sept., 1912.)—Investigation of the freezing-point curve shows that thallium and tellurium form two compounds, namely, Te_2Tl_3 and TeTl. The former corresponds with a maximum in the curve at 428°, whilst the latter corresponds with a break in the curve at 305° and 40·5 % Te. The eutectic point lies at 200° and 58·5 % Te. The alloys separate into two liquid layers between the limits 1·5 and 24 % Te at 393°. Solid solutions are only formed by the compound Te_2Tl_3 with 5·5 % of Tl. This compound is very brittle, whilst the compound TeTl, which forms long needles, is much less so. T. S. P.

1365. *Fixation of Nitrogen by Barium Oxide and Charcoal.* **T. Ewan** and **T. Napier.** (Soc. Chem. Ind., Journ. 32. pp. 467–474, May 15, 1913. Paper read before the Scottish Section.)—That a mixture of baryta and carbon, when calcined in air, readily combined with nitrogen, was observed by Margueritte

and de Sourdeval in 1860 ; J. B. Readman technically carried out the reaction about 1895. The authors have since 1909, unknowingly at first, been working on the lines of Kühling and Berkhold, heating a mixture of 2 parts of barium carbonate and 1 of charcoal in an electric Heraeus furnace while passing nitrogen through the tube. The absorption of N_2 begins between 900° and 930°, and increases with rising temperature, $2\frac{1}{2}$ per cent. of the nitrogen used being fixed at 960° and 10 per cent. at 1000°. The products are BaO, $Ba(CN)_2$ and $BaCN_2$; the reactions are very complicated, and not more than half the barium oxide can be converted in this way into a nitrogen compound. The two reactions $BaO + 2C + N_2 \rightleftarrows BaCN_2 + CO$ and $BaO + 3C + N_2 \rightleftarrows Ba(CN)_2 + CO$ seem to be reversible, but a less active compound BaO, $Ba(CN)_2$ also appears to be formed, and the reaction $Ba(CN)_2 = BaCN_2 + C$, decomposition of the cyanide by heat, is not reversible. Some barium carbide is probably formed out of BaO and C before the absorption of N begins. Barium ferrocyanide, heated alone or mixed with charcoal, yields a mixture of barium cyanide and cyanamide. The experiments, which were made in the laboratory of the Cassel Cyanide Co., do not fully explain the phenomena. H. B.

1366. *Hydrogen from Water and Coal from Cellulose at High Pressures and Temperatures.* **F. Bergius.** (Soc. Chem. Ind., Journ. 32. pp. 462–465; Discussion, pp. 465–467, May 15, 1913.)—Further particulars of the researches noticed in Abstract No. 1769 (1912). The author and Specht apply higher temperatures, 340°, and therefore much higher pressures than Stein and Klason had done. Iron heated with water is completely turned into a finely-divided powder of Fe_3O_4, not only on the surface, and a hydrogen of 99·95 per cent. is produced which need not be compressed for transport. When water is sealed up with cellulose, peat, etc., it remains liquid and retains its high specific heat ; hence local superheating is prevented, the liquid water acting as a material for storing heat, and the temperature can easily be kept constant throughout the mass. Cellulose and water at 340° turn in twelve hours into a black powder containing 84 per cent. of C, 5 of H, and 11 of O ; some CO_2 is also found in the vessel. The H percentage is as high as in bituminous coal. Eight hours' heating at 340° yields the same result as 64 hours at 310° ; thus a rise of 30 deg. accelerates the reaction $8 = 2^3$ times, or an elevation of the temperature by 10 deg. doubles the speed of the reaction. It is not possible apparently to raise the carbon percentage above 84 by these means, and the resulting dry powder does not resemble coal unless it be heated for hours to 340°, while being submitted to very high mechanical pressure ; pressure alone at ordinary temperature will not yield a product like anthracite, though it does so in Nature in the course of thousands or millions of years. The author distinguishes carbonisation from formation of anthracite ; he considers the latter as a pressure effect. The vessels, up to 200 galls. capacity, are made of special steel and are fitted with joints after Kirchenbauer, used by Haber and le Rossignol, consisting of cone-shaped ends, clamped and forced together by a screw, there being merely a circular line of contact ; these joints keep tight at 400° and 150 atmos. for several weeks. The discussion concerned mainly the nature of the resulting coal. H. B.

1367. *Molecular Refraction.* **G. Pólya.** (Phys. Zeitschr. 14. pp. 352–355, April 15, 1913.)—Examines the formula $M/d \times (D-1)/D$, in which M is the molecular weight, d the density, and D the dielectric constant. This is closely related to the modern formula involving the refractive index instead

of the dielectric constant. The constancy of the formula is tested by an imaginary cycle of experiments, in which the condenser containing the substance is first discharged in a reversible manner ; then a chemical reaction is made to take place in the dielectric ; then the electrification is restored while compensating electrostriction by suitable pressure ; and finally the reaction is reversed and the work recovered. If the amount of work in the second stage is A_0 and in the fourth stage A_p, the surface density σ and the p.d. V, then $A_p = A_0 + \frac{1}{2}V\sigma - \frac{1}{2}V'\sigma$. Since in the limit the reversible max. work is a measure of the "avidity" of the reactions, the reaction is accelerated in an electric field if the amount of electric energy is thereby increased, and *vice versa*. E. E. F.

1368. *Influence of Diffusion on E.M.F. produced in Solutions by Centrifugal Action.* **W. L. Miller.** (Amer. Electrochem. Soc., Trans. 21. pp. 209–217, 1912.)—The author has calculated the influence of diffusion on the e.m.f. produced in Tolman's experiments [Abstract No. 173 (1911)] by centrifugal action, and shows that it is not large enough to influence the results, as after 15 minutes it would only amount to 0·021 millivolt. T. M. L.

1369. *Orientation of Liquid-crystals by Plates of Mica.* **C. Mauguin** (Comptes Rendus, 156. pp. 1246–1247, April 21, 1913.)—When azoxyanisol is melted between cleavage plates of mica the liquid-crystals develop in a peculiar manner. Taking the well-known star-figure which is produced on striking a mica-plate with a blunt point, the 6 rays of the star are (1) parallel to the axis of the crystal, (2) at 60° to the right and left. The liquid-crystal sets itself with its optic axis parallel to one of the secondary rays of the lower plate of mica (*e.g.* the one to the right of the axis of the mica-crystal), but on passing through the film of liquid-crystal the orientation gradually changes until at the upper surface the optic axis is parallel to the other secondary ray of the mica (*e.g.* the one to the left of the axis of the mica-crystal). These two rays are therefore not identical in their properties, since, when the cleavage is made, an identical behaviour is possessed by the one to the right on the lower surface of the cleavage and the one to the left on the upper surface of the cleavage, as viewed from above the composite-plate. If viewed from the cleavage-plane itself the two rays with identical properties, would, of course, be oriented in the same way. T. M. L.

1370. *Influence of Colloids and Fine Suspensions on the Solubility of Gases in Water.* III. *Solubility of Carbon Dioxide at Pressures lower than Atmospheric.* **A. Findlay** and **T. Williams.** (Chem. Soc., Journ. 103. pp. 636–645, April, 1913.)—By extending the investigations of Findlay and Creighton [Abstract No. 1167 (1910)] to lower pressures confirmation has been obtained of the view that in presence of colloids the solubility-curve of a gas under varying pressure exhibits a minimum or else falls with increasing pressure to a constant value. Thus in the case of dextrin, the solubility of CO_2 which was steady at higher pressures, is shown to increase at the lower pressures now investigated. T. M. L.

1371. *New Electric Properties of a Semipermeable Membrane of Copper Ferrocyanide.* **R. Beutner.** (Journ. Phys. Chem. 17. pp. 344–360, April, 1913.)—(1) A precipitation membrane of copper ferrocyanide behaves like an electrode, reversible for monovalent positive ions of different kinds. (2) The e.m.f. of the system $K_4Fe(CN)_6$ aq. sol.—precipitation membrane—$CuSO_4$ aq. sol. is due to a concentration cell with $K^{\cdot}$ ions. The $K^{\cdot}$ salt concentration

of the $CuSO_4$ solution is due to K_2SO_4, which is generated by the formation and steady increase in thickness of the membrane. The $K^{\cdot}$ concentration in the boundary region of the $CuSO_4$ solution, which is essential for the e.m.f., depends mainly on the velocity of diffusion into that part of the $CuSO_4$ solution which is free from K_2SO_4. T. M. L.

1372. *Electro-analysis of Copper, Antimony, Bismuth, and Tin with Acidified Chloride Electrolytes.* **E. P. Schoch** and **D. J. Brown.** (Amer. Electrochem. Soc., Trans. 22. pp. 265–275, 1912.)—The authors find that Cu, Sb, Bi, and Sn may be deposited quantitatively and in good form from hydrochloric acid electrolytes if suitable reducing agents (formalin, hydroxylamine hydrochloride, oxalic acid, etc.) are added to them. It is possible to separate copper from tin and estimate both from the same sample of electrolyte, using the method of graded potential, thus reducing the otherwise troublesome analysis of bronze to a very simple operation. Metals with a potential more positive than that of tin do not interfere with the estimation of copper by this method. These methods present many advantages over older methods. The electrolytes are easily prepared, because all of the metals are soluble in *aqua regia*, and all of their compounds are soluble either in this reagent or in hydrochloric acid. The electrolytes are free from odour, and the results indicate that the deposits are probably free from inclusions. Rotating electrodes are employed and the methods are rapid. Full experimental details are given. [See Abstract No. 1732 (1908).] T. S. P.

1373. *Concentration-changes in the Electrolysis of Copper-sulphate Solutions.* **C. W. Bennett** and **C. O. Brown.** (Journ. Phys. Chem. 17. pp. 373–385, May 15, 1913.)—It has been noticed previously [see Abstract No. 1294 (1912)] in the electrolysis of copper-sulphate solutions with a rotating copper kathode, that the potential-drop across the cell, with constant current, increases with an increase in the speed of rotation. This observation has been confirmed for variations in the speed of rotation from 1000 to 5000 revs. per min. Investigation of the various factors which may cause an increase in potential, showed that the increase was due to a rise in the potential at the rotating kathode, where the equilibrium $Cu + Cu^{\cdot\cdot} \rightleftarrows 2Cu^{\cdot}$ exists. As the rotation increases and the stirring becomes more efficient, the cuprous ions are removed faster and faster, and the solubility of the copper is therefore increased, giving rise to a higher voltage. The increase in the drop of potential between the electrodes is also partly due, in all probability, to an increased resistance of the electrolyte. When a solution of cuprous chloride in hydrochloric acid is used there is a decrease, instead of an increase, in potential. This is due to the removal of the cupric ions at the electrode, which are in equilibrium with the cuprous ions and the copper of the electrode. The potential of a rotating electrode in nitric acid diminishes with increasing rate of rotation, owing to the increasingly efficient removal of the film of nitrous acid, whereby the tendency of the copper to dissolve is diminished, and therefore its voltage. The solution pressure of a metal is increased if the size of its crystals be decreased. This is made apparent by an increase in the potential of the metal as the crystal size is decreased, by hammering or burnishing, for example. It is also shown by the fact that fine-grained metal (electrolytic copper) is electro-positive to more coarsely crystalline metal (cast copper). T. S. P.